FY2012 Specialty Crop

Block Grant Program – Farm Bill

Idaho State Department of Agriculture

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Final Performance Report

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Preparing Idaho Viticulture for Future Extreme Temperature Events: Wine Grapes' Need for and Tolerance to Cold

Subrecipient
Boise State University

Project Summary
Wine grapes need cold exposure in the fall and winter to break bud in the spring, yet the vine can be severely injured by cold depending on the dormancy of the buds at the time of exposure. Grapevine buds undergo three well-defined phases of dormancy: para-, endo-, and ecodormancy. Transitioning from endo- to ecodormancy requires exposure to cold and dormancy transition is thought to correspond with changes in bud cold hardiness. The objective of this project was to determine, for two of the most widely planted wine grape cultivars in the Snake River Valley American Viticultural Area (AVA): Cabernet Sauvignon and Chardonnay, the effective cold temperatures that release buds from endodormancy and the relationship between phases of dormancy and cold hardiness. For this purpose, cane sections of Cabernet Sauvignon and Chardonnay were exposed to cold temperatures under controlled and natural conditions. After exposure to cold temperatures, the phase of dormancy was determined through a bud break bioassay, while bud and cane cold hardiness was measured by differential thermal analysis. Some of the data generated was also used to compare the observed bud cold hardiness to that estimated by a mathematical model that predicts cold hardiness based on ambient temperatures. Knowledge of the requirements to break bud dormancy and of bud cold hardiness can be useful for cultivar selection in future vineyard development. Similarly, identification of a model that reliably predicts cold hardiness for the climatic conditions of southwestern Idaho would allow growers to estimate in real-time the probability of crop damages or losses during a cold temperature event.

Project Approach
Analysis of the effective chilling temperatures that break bud endodormancy
Canes with endodormant buds were collected from field grown Chardonnay and Cabernet Sauvignon vines growing in Parma, Idaho. The canes were wrapped in moist paper towels and cellophane to prevent drying. The effect of chilling temperatures on breaking bud endodormancy was analyzed after exposing the buds to temperatures of 3, 0, -3, -5, or -8°C for three weeks. At the end of this period, the dormancy status of the buds was estimated by a budbreak bioassay. Briefly, canes were cut into one node sections and placed in wet foams in planting trays (Fig. 1 A and B). These sections were placed in a greenhouse and exposed to forcing conditions that allow budbreak of para- and ecodormant buds (15 h photoperiod and day/night temperatures of 25/20 °C). Subsequently, researchers evaluated the effect of each chilling temperature on days to budbreak and survival of unbroken dormant buds.

The optimum temperature for breaking endodormany differed between the two cultivars. For Chardonnay, the highest percent budbreak and the lowest average days to budbreak occurred at -3°C (Fig. 2A and 3A). Temperatures of 0, 3, and -5 °C also induced endodormancy release in Chardonnay, albeit at a slower pace. For Cabernet Sauvignon, the most effective temperature for breaking endodormancy was 3°C followed by 0°C. Negative temperature had little effect on releasing Cabernet Sauvignon buds from endodormancy, and in general the average days to budbreak were higher in Cabernet Sauvignon than in Chardonnay (Fig. 2B and 3A). In both cultivars, -8°C did not induce budbreak and resulted in very high rates of bud mortality (Fig. 3B)

Figure 1. Experimental approach used to determine the phase of bud dormancy and bud cold hardiness. A and B, Budbreak bioassay. Cane sections (nodes 4-8) were cut to one node segments and loaded into floral wet foam blocks. Percent bud break was determined after exposure to forcing conditions (15 h photoperiod and day/night temperatures of 25/20 °C) for 60 days. C, Tenney environmental chamber used to determine low temperature exotherms of bud samples.

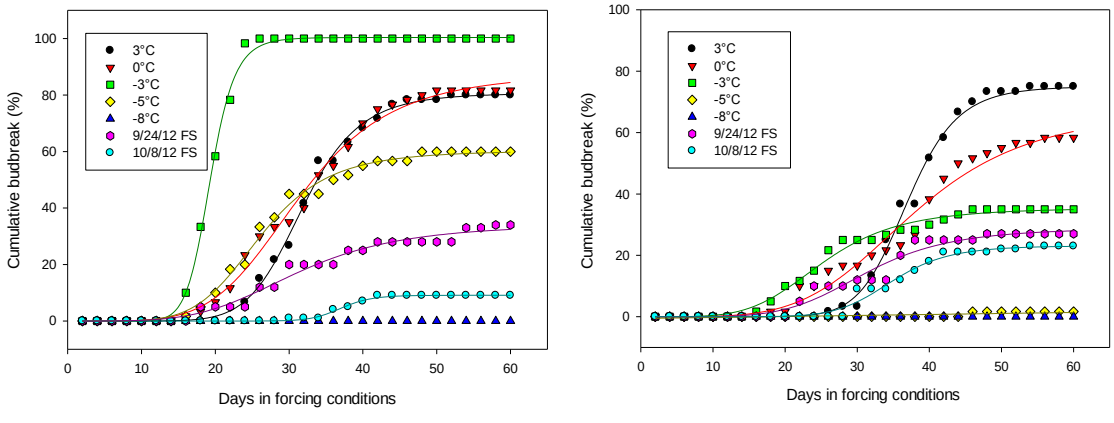
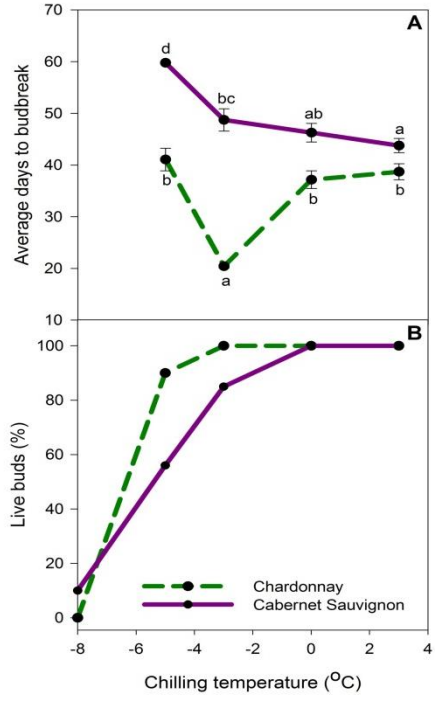


Figure 2. Cumulative percent budbreak for Chardonnay (A) and Cabernet Sauvignon (B) under 25/20°C (day/night) temperature with or without a prior 3 wk exposure to 3, 0, -3, -5, or -8°C. Unchilled controls were sampled on 9/24/12 and 10/8/12 and chilled canes were sampled on 10/8/12.

Figure 3. Elapsed days to budbreak during exposure to 25/20 °C (day/night) for single node cane segments that had been previously exposed for 3 wks to 3, 0, -3, -5, or -8°C (A) and bud viability after cold exposure (B). For a particular cultivar, means labeled with different letters are significantly different ($p < 0.01$) based on the Holm-Sidak test.



Changes in dormancy phases under field conditions

Canes were sampled biweekly through the fall and early winter. The dormancy status of the buds was estimated by the budbreak bioassay described above, except that the node sections were directly transferred from the field to greenhouse conditions. Buds were considered endodormant if budbreak was less than 50% after 60 days of exposure to forcing conditions.

Under field conditions, both cultivars entered endodormancy in September, but Chardonnay transitioned from endo- to ecodormancy earlier (mid-October) than Cabernet Sauvignon (late October) (Fig. 4A). In addition, the average days to budbreak were lower in Chardonnay than Cabernet Sauvignon, particularly during ecodormancy (Fig. 4B).

Examination of cold hardiness during endo- and ecodormancy

Changes in bud cold tolerance through the endo- and ecodormant period were evaluated on samples collected through the fall and winter. Potential differences in cold hardiness between the two cultivars were determined by differential thermal analysis (DTA). Briefly, canes and buds were placed in a programmable Tenney environmental chamber (Fig. 1C), and the temperature gradually decreased to -40°C. The DTA system recorded the temperature at which the tissue released heat (low temperature exotherm) as result of freezing and death.

Both cultivars reached maximum cold hardiness in mid-winter when buds were ecodormant. For Chardonnay, the lethal temperature for 50% of buds (bud LTE_{50}) at the time of dormancy transition and at mid-winter was -19.2 and -28 °C, respectively. Similarly for Cabernet Sauvignon, bud LTE_{50} during dormancy transition and at mid-winter was -17.2 and -25.8 °C, respectively (Figure 5).

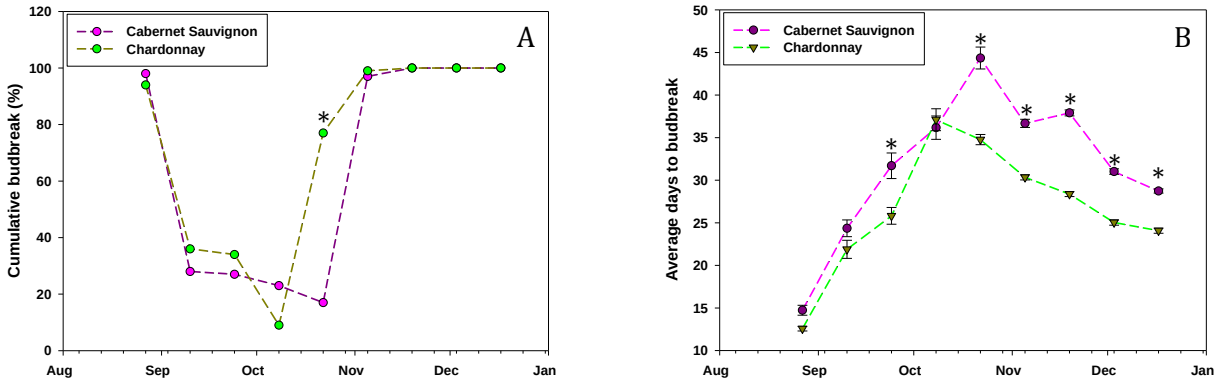


Figure 4. Cumulative budbreak (A) and average days to budbreak (B) of samples collected between August 2012 and January 2013. After collection, node sections were exposed to 25/20°C (day/night) for 60 days. Asterisks (*) indicate sampling dates at which differences between cultivars were significant ($p \leq 0.05$).

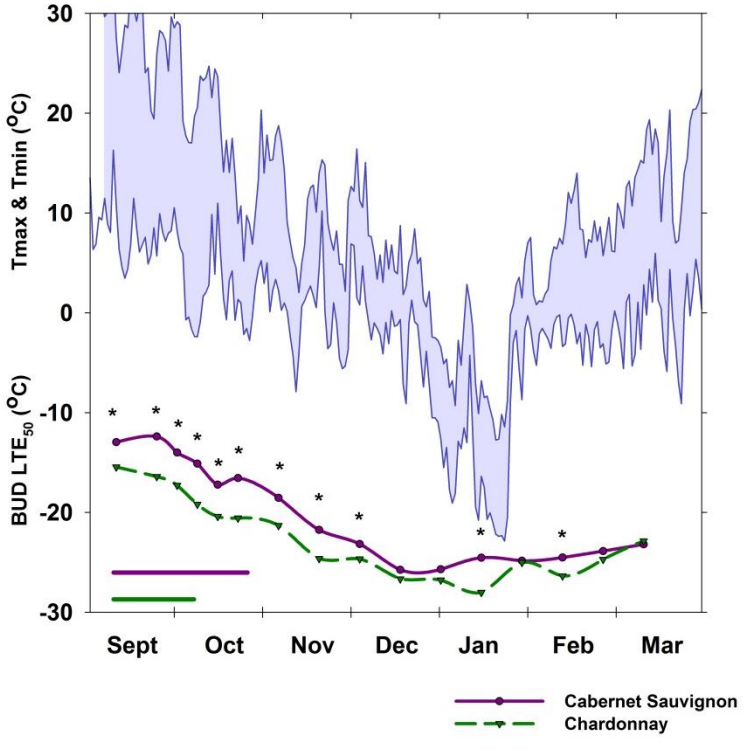


Figure 5. Bud cold hardiness of Cabernet Sauvignon and Chardonnay from September 2012 through March 2013 in Parma, Idaho. The figure includes daily maximum and minimum ambient temperature. Asterisks (*) indicate dates at which differences in bud LTE_{50} were significant ($p \leq 0.05$). Purple and green bars above the x-axis indicate the endodormant period for Cabernet Sauvignon and Chardonnay, respectively.

Comparison of the observed cold hardiness values with the predictions of the Ferguson Thermal Dynamic Cold Hardiness Model

The observed bud cold hardiness values and weather data on daily minimum, maximum and mean temperatures were inputted into the Ferguson Model. This model uses a unique set of model parameters for each cultivar. Evaluation of the predictive capacities of the model was performed using the Willmott Index of Agreement and correlation analysis.

During the initial acclimation phase in fall, the model predicted higher cold hardiness than the observed values (Fig 6). In contrast, during the midwinter period, the predictive values were very similar to those observed. Based on the Willmott index, the strength of the agreement was higher for Cabernet Sauvignon than Chardonnay. However, both cultivars showed high index of agreement, 0.95 and 0.85 for Cabernet Sauvignon and Chardonnay, respectively.

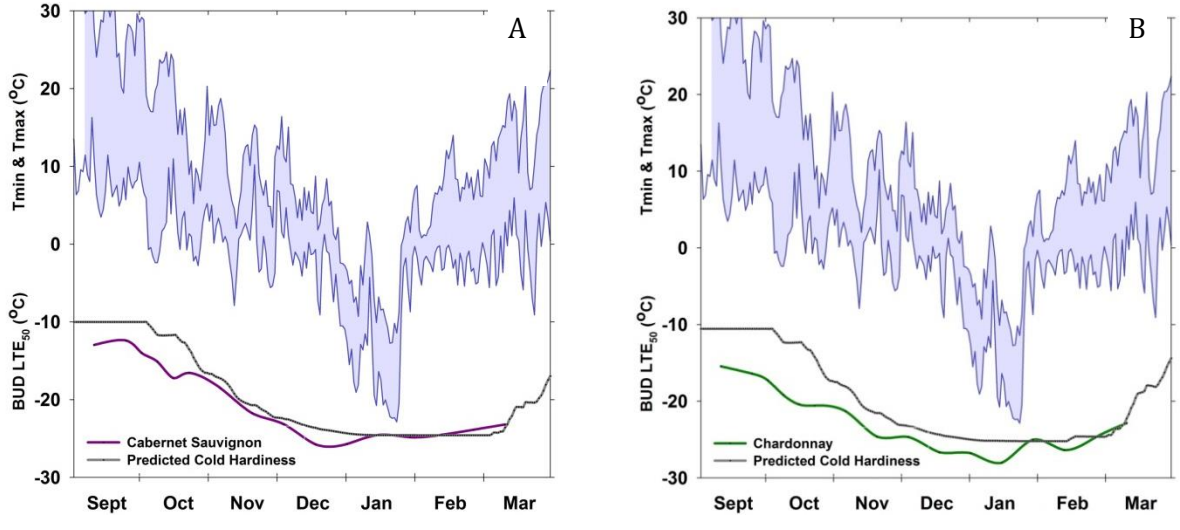


Figure 6. Measured and predicted bud cold hardiness (LTE_{50}) of Cabernet Sauvignon (A) and Chardonnay (B). Predictive values were estimated with the Ferguson model based on temperatures measured at the field site. Graphs also include daily minimum and maximum temperatures during the 2012- 2013 winter season.

All aspects of the project were conducted in collaboration with the project's partner Dr. Krista Shellie at the USDA-ARS in Parma. The USDA-ARS research vineyard provided the grapevine material used in the project and measurements of bud LTE_{50} were also conducted at the USDA-ARS lab in Parma.

Results were presented at the meeting of the Botanical Society of America , where approximately 1000 attendees were present. The poster was also discussed with approximately 10 other researchers. The data was disseminated in a more informal manner, through short presentations and word of mouth between several vineyard owners and managers working together on cold hardiness issues.

Goals and Outcomes Achieved

All the goals of the original proposal were achieved through the activities described under *Project Approach*. The project generated new knowledge about environmental regulation of bud dormancy in grapevines and identified that the optimum chilling temperature to break endodormancy was lower in

Chardonnay than Cabernet Sauvignon. The research conducted also revealed that through the fall and winter Chardonnay was more cold-hardy than Cabernet Sauvignon. This suggests that Chardonnay is better suited for sites with deep-midwinter freezing than Cabernet Sauvignon. Comparison of observed bud cold hardiness with the predictions of the Ferguson model indicated that this model is adequate to predict bud cold hardiness in the Snake River Valley AVA.

All data obtained will be provided to Dr. Keller's lab. Dr. Keller is in the thesis committee of Jacob Cragin and has seen most of the results of the project. Before creating a website to predict cold hardiness or expand the website at WSU to predict cold hardiness in Idaho, the data must be discussed in more detail. Based on our results to date, the WSU model accurately predicts cold hardiness in Idaho. However, this conclusion is based on only two years of data. It must be decided if this is sufficient to launch the website or is more prudent to gather more data.

Measurable outcomes were also met through training students and presentation of results. The project provided an opportunity to train a graduate student in issues of importance to Idaho's Viticulture. The graduate student, Jacob Cragin (Jake), is currently the manager of several vineyards including two in Idaho. In addition, two undergraduates, Eric Roberts and Russell Holten helped Jake with the budbreak bioassays and gained knowledge of grapevine physiology and anatomy. The information gained through the project was made available to the Idaho wine industry in an oral presentation at their annual meeting in 2013. Information was shared with the research community by presentation of a poster at the 2014 annual meeting of the Botanical Society of America in Boise and part of work on cold tolerance was included in a publication. The results were also presented at the Idaho Grape Growers and Wine Producers Commission where close to 100 growers and producers were in attendance.

Beneficiaries

Results from this project will benefit the Idaho wine industry. According to Winemakers, LLC, the revenue lost from extreme temperature events at Skyline Vineyards in Nampa, Idaho in 2008 was estimated at $5000/acre. According to these figures, loss of 100 acres of vineyard could result in a loss of $500,000 per season. Estimating that it could take an additional 1 to 4 years to return to full production, depending on the extent of the cold damage or vine death due to the cold event, there could be lost revenue of $1,000,000 to $2,000,000 or more. The results of the project indicate that the Ferguson model can predict rather accurately bud cold hardiness in the Snake River Valley AVA. The use of this model would allow vineyard managers in Idaho to be better prepared for extreme temperature events and potentially reduce the amount of vine damage or loss. For example, if the model predicts low cold hardiness at a particular time of the year, the managers could run fans to reduce the impact of a forecasted extreme cold event. Using the model with meteorological data from Idaho may also help to identify cultivars that are suitable for Idaho climatic conditions. These cultivars could then be tested on field trials.

Lessons Learned

Apart from the information and new knowledge discussed above, one unexpected result was the lack of correlation between endodormancy and cold hardiness. Both cultivars increased cold hardiness during ecodormancy. These results indicate that the factors that determine endodormancy are not closely linked with those responsible for cold hardiness. Analysis of molecular differences between endo- and ecodormant buds may help to identify signals and metabolic processes that regulate cold hardiness. Another lesson learned was related to changes in the availability of equipment. In the original proposal, funds were requested to purchase temperature control units that can maintain temperatures below 0°C.

By the time the funds were received, Dr. Shellie had purchased these units with different funds. Consequently, Dr. Shellie's were used units for incubation of canes and buds and the temperature control units were not purchased.

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Additional Information

Publications

Shellie K, Cragin J, Serpe M (2014) Performance of Alternative European Wine Grape Cultivars in Southwestern Idaho: Cold Hardiness, Berry Maturity, and Yield. HortTechnology 24: 138-147

Cragin J, Grapevines responses to cold in the Snake River Valley American Viticultural Area. MS Thesis, Boise State University (in preparation).

Presentations

Krista Shellie, Cragin J (2013) Presentation at annual meeting of the Idaho Grape Growers and Wine Producers Commission

Cragin J, Shellie K, Serpe M (2014) Endodormancy release in grapevine buds: chilling requirements and changes in cold hardiness. Annual Meeting of the Botanical Society of America

Trials of Idaho Dry Bean Seed in Durango and Zacatecas, Mexico

Subrecipient
Idaho Bean Commission

Project Summary
The intended purpose of this project was to increase exports of US varieties of pinto and black seed grown and certified in Idaho, by proving to growers in Durango and Zacatecas that their yields will be significantly improved if they invest in purchasing fresh, disease-free seed each growing season. It was identified prior to this project, that the practice of saving seed from previous harvests for replanting in subsequent growing seasons is more prevalent in these states. This practice promotes disease and significantly decreases yields.

There had been numerous requests for tests from growers in Durango and Zacatecas, however due to the imperative nature of unbiased, reliable trial managers, the commission had refused to sponsor them in these two areas. Once the Mennonite community partners were identified, the commission felt it satisfied their criteria for dependable partners. It is important to note that approximately 3,335,900 acres are engaged in agriculture in this region with about 14% of it being done under irrigation and 86% under dryland conditions.

Project Approach

The Idaho Bean Commission collaborated with Productores Unidos de Ex Hacienda La Honda S. A. de C. V., located in Campo Número Seis, Colonia Menonita La Honda in Miguel Auza, Zacatecas for two test plots that were established previously in the region, one under irrigation and the second under dryland with the traditional agricultural system The objectives were:

1. To establish two plots for planting certified Idaho bean seeds in the state of Zacatecas in order to evaluate Idaho´s seeds and create trade relation between the two states.
2. Determine the varieties of certified Idaho bean seed of greater adaptability to the Zacatecas environment.
3. We also wanted to evaluate; yield, days to flowering, days to physiological maturity, pods and grains per plant, and weight of 100 grams of grains or seeds

Important date for preparing the ground:

- Soil analysis: April 18, 2013 (pH: 7.47, CE (dS/M): 0,77, %MO: 0.81)
- Fallow land: May 2, 2013
- Tracking: May 3, 2013
- Plowing: May 6, 2013
- Pre-planting irrigation: May 7, 2013

The pinto bean varieties that were evaluated from Idaho were: Quincy, windbreaker, Max, Othello, Bill-Z, Lariat, Stampede, Medicine Hat, and UI-196. Zacatecas varieties included: Pinto Centenario, Pinto Saltillo, National Bill-Z. For black beans, Idaho varieties used were: Zorro, Jet Black, Eclipse, Domino, T-39, Blackvelvet and Jaguar. The Zacatecas seed varieties were T-39, N-8025 (Bean Zac-101) and San Louis.

For the trials in Durango; the Idaho Bean Commission signed a contract with Comercializadora Agrounión, and they concluded the following:

The commercialization of the Idaho bean seed faces the subsequent factors:

a) Oxidation as a determining factor making the sale of seed a very complicated process
b) Farmers are not used to planting certified seed, making the old practice of planting seed from the previous harvest very common.
c) The influence of the government on incentives to buy certified seed makes farmers to vary their purchases programs. One year, the government can give financial incentives for seed for the producers, but others may not.

At the time, the University of Idaho Foundation's Seed Manager, Kathy Stewart-Williams acted as a Consultant for the two trials. She suggested varieties based upon the performance of pinto varieties in the prior Chihuahua tests. She also compiled a list of U.S. black varieties for the trial in Zacatecas. During the trial technician and manager's visit to Idaho, she gave them written recommendations for cultivation and outlined how she wanted the trials evaluated at harvest time.

The Administrator for the Idaho Bean Commission was responsible for negotiating MOUs with the trial managers, completing quarterly financial reports to ISDA, six-monthly progress reports to ISDA, and now the final report to ISDA at the conclusion of the grant. During the grant process, she facilitated communication between all parties associated with the trials, and scheduled monthly conference calls to assure compliance with timelines. She worked alongside the trial managers, for field days' arrangements; including organizing an educational speaker for field days and production of informational materials for field day participants. The board for the Idaho Bean Commission consulted and oversaw all aspects of the trials.

The Durango and Zacatecas Trial Managers and technicians were responsible for securing land, preparing land for planting, planting, and caring for trials. They were also responsible for organizing the field day and issuing invitations to growers, harvesting, and evaluating the results according to Stewart-Williams' guidelines. Post-harvest, they co-mingled the seed and destroyed it by heat so that it cannot be replanted.

ISDA Trade Office Manager, Armando Orellana acted as a consultant for all parties to the trials. He attended field days and acted as a translator for educational presentations

The IBC commissioners who attended the field days, along with Armando Orellana, would have had opportunity to examine the field trials and verify that the trials were being conducted as per trial protocol, and was outlined in the reports previously submitted by the managers from Durango and Zacatecas. The final data set would have been yield and seed size, and that information was included in the trial managers reports as well which are attached. The field day in Zacatecas was attended by 130 farmers, and the one in Durango was attended by closer to 100. Both Trial Reports were printed and made available at both field days along with the Idaho Bean Schools, which is attended by about 200 farmers total. So in summary, these results and presentations were made available to a total of about 430 bean farmers in Idaho and in Mexico.

Goals and Outcomes Achieved

At the end of the trials, it had been found that the best performing varieties were Pinto Saltillo and Pinto Centenario, which was indicated by the trial managers that these were the materials with total adaptability to the soil and climatic conditions of the region. This is what prompted us to bring back a sample of Pinto Saltillo, for research purposes as was noted in the October 2014 progress report. For the black bean varieties, the best performing were Black San Luis and N-8025, which again indicated that these are materials with full adaptability features for the soil and climatic conditions of the region.

VARIETY	FLOWERING (DAS)	MATURITY PHYS. (DDS)	HEIGHT (cms)	PODS/ PLANTS	GRAINS / PODS	GRAINS / PLANT	WEIGHT 100 SEEDS (GRS)	YIELD KG/HA
STAMPED	46	89	40	17	4.4	76.23	34.0	2264
WINDBREAKER	49	91	42	18	4.0	69.32	34.2	2551
OTHELLO	53	89	38	18	3.5	60.33	30.3	1465
QUINCY	49	85	48	16	4.6	72.67	33.5	1909
MAX	44	89	47	20	3.0	60.89	34.5	1820
BILL Z	38	93	50	18	3.5	65.73	34.2	1990
UI-196	51	89	40	20	3.0	59.32	33.2	1413
LARIAT	47	84	52	18	3.6	62.27	34.8	1876
MEDICINE HAT	45	89	38	28	3.6	91.57	32.8	2246
BILL-Z NACIONAL*	39	89	39	15	3.4	51.58	34.2	1678
PINTO SALTILLO*	40	93	46	27	4.1	107.90	33.1	3068
PINTO CENTENARIO*	41	91	41	28	3.2	90.89	36.9	2444

Measurable Outcomes

- We were able to complete our first measurable outcome by supplying seed for six US black bean varieties and nine US pinto bean varieties of Idaho certified dry beans for the trial. Unfortunately the results were not as we expected and four U.S. varieties of Idaho Certified seed did not end up outperforming the seed of "check" varieties grown in Mexico.
- For the second goal, exports of Idaho certified seed to Mexico increased for part of it; two years after the trial in 2013, there were phytosanitary certificates issued for 2,369,528 pounds. Unfortunately the trend did not continue in 2014 and only 190,621 pounds were completed.
- Our third goal we also had mixed experiences, as in 2014 there were 1,400 acres of black varieties harvested and 19,000 pinto varieties. While black varieties decreased, harvested acres for the two varieties combined increased far exceeded our target of 5%, to a total of 155% increase.

Beneficiaries

This project benefits all Idaho and U.S. exporters that increase their seed stocks, and/or that have production facilities in Idaho. Here in Idaho, beans are considered a rotation crop, so the number of growers may vary greatly from year to year, however it has been estimated there are over 500 bean growers and are approximately 30 bean dealers.

Lessons Learned

Despite the challenges that we faced during this trial, the Commission still believes that there is strong potential for Idaho bean seed in Mexico. As previously mentioned, the commission brought some Pinto Saltillo seed up from Mexico to Idaho for research purposes. There could be opportunity for the variety to perform well in the US on dry land farms in the Midwest or in Idaho on short water years. Idaho may also have a niche in improving this seed and being able to sell it back to Mexican growers. It then should be without the disease issues they currently have by using their existing methods of saving and replanting seed. After trials have been completed in Idaho, the Commission would like to compare the Idaho Pinto Saltillo to the original Mexican Pinto Saltillo, and see which one performs better in the Mexican climate. This is a topic the commission is currently in big discussions about and will continue to focus their efforts on in the near future.

One big lesson the commission learned, specifically on this trial is the different watering practices exist between Idaho and the Mennonite farmers. While their cultural practices are still good, the commission feels they do not allow the beans to reach their full potential before turning off their water. Here in Idaho, it is a common practice to water the beans until the fourth bloom, and perhaps one or two times after that. This allows the plants more time and nourishment. It is very common for the Mennonite farmers to turn their water off at first bloom. It appears their varieties have been accustomed to this practice, which is why they outperformed, as noted in the trial comments above. The commission hypothesizes that if given the more typical Idaho farming practices, the results would have been different. While the commission recognizes that this would be an educational process in order to change the way that the farmers grow beans in Mexico, fortunately the Mennonites foster a culture where they are very close-knit. They tend to be interconnected and communicate very well amongst themselves on what works well and what does not on their farms. They also tend to be competitive and hold an annual convention where they share prices, data and share information on what worked best for their crops. If more trials are ever done, the commission feels that writing up a more in-depth protocol will need to be written, specifically focusing on watering practices.

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Raising Awareness and Increasing Market Share of Idaho Wine through Advertising and Promotion

Subrecipient
Idaho Grape Growers and Wine Producers Commission

Project Summary
The Idaho Grape Growers and Wine Producers Commission (IWC) set a goal to continue to raise the awareness of the Idaho wine industry while building on the momentum that the industry has recently gained. Along with increasing the awareness of the Idaho wine industry, it was also a goal to increase the consumption of Idaho wine within the state, therefore assisting in boosting the economy. In order to get the word out, the IWC used a variety of different media and promotional outlets such as print, web, radio, and billboard advertising, in addition to traveling and pouring Idaho wine at events for consumers to sample and working with marketing and public relations agencies to produce the most positive message possible. This all helped gain awareness for Idaho's emerging wine region.

The goal of the Idaho Grape Growers and Wine Producers Commission is to market and promote all wineries and wine grape growers. The projects accomplished with the assistance of this specialty crop grant went a long way in raising awareness of this growing commodity in Idaho through advertising and promotions. Many are not aware of the high quality Idaho wine available, and this project helps put Idaho on the map as a state to look to for wine.

Project Approach
To begin several of the projects outlined in the grant proposal, the IWC met with a marketing agency as well as a public relations firm to outline specific interim goals and determine the best course of action to accomplish these goals. Each of the companies was chosen by going through a request for proposal process required for state agencies, and was completed prior to the beginning of the grant cycle. Rizen Creative was hired as the marketing firm and Red Sky Public Relations was hired for PR work.

While Rizen Creative worked on developing the advertising creative, IWC scheduled the advertisements with the specifically chosen outlets including the: Boise Weekly, Idaho Business Review, Wine Press Northwest, SIP Northwest Magazine, Spokesman Review, North Idaho Cuisine, The Inlander and Facebook Online. Rizen Creative was also tasked with developing the collateral creative for the 100 street banners that the IWC scheduled to have hung throughout downtown Boise through the month of June, which was declared by Governor Otter to be Idaho Wine Month, along with the design for two freeway billboards that were place along I-84. One hundred street pole banners were hung throughout downtown Boise representing wineries within the state of Idaho, the Idaho Wine Commission, and I Support Idaho Wines' general campaign. The locations of the billboards were specifically chosen to attract visitors in close proximity to the heart of Idaho wine country. There were three different billboard companies that the IWC contacted to determine the best pricing and that had billboards located within the desired area. There were two separate billboards, one viewed heading Westbound before exit 33 in Nampa, Idaho and the other heading Eastbound after exit 27 in Caldwell, Idaho.

The IWC attended two festivals in 2013 to represent the industry and pour Idaho wine for consumers to taste. This is an important aspect of promoting Idaho wine as it gives consumers that may not be in close proximity to many of the wineries a chance to taste the wine before purchasing in a store since more

people are likely to want to try before they buy. The IWC attended the Sun Valley Wine Auction (1,400 attendees) on July 20, 2013, and the Festival at Sandpoint on August 11, 2013 (2,208 glasses of wine poured). There were wines poured from fifteen different wineries between the two events.

Planning began in June for the boot camp to educate members of the media and restaurant industries about Idaho wine. The one-day boot camp took place on October 21, 2013, with 36 industry members in attendance.

By the end of February 2013, all advertisements between March and June 2013 were scheduled with various publications. These advertisements include promotions of the Idaho wine industry, the I Support Idaho Wine campaign, Idaho Wine Month, UnWined at the Movies and Savor Idaho.

Through November 2013, additional advertisements were placed with the following publications and marketing outlets: Cumulus Radio, Boise State Public Radio, Boise Weekly, Idaho Business Review, The Inlander, North Idaho Cuisine, Spokesman Review, SIP Magazine, Wine Press Northwest, Facebook and Boise Young Professionals. Boise Young Professionals was an additional outlet added to help disperse grant funds.

The Restaurant Boot Camp took place on October 21. This was originally set to be focused on the media, however throughout the planning, it was determined it would be better suited to focus on restaurant personnel in an effort to have more Idaho wine poured within the representatives' establishments and education them on Idaho wine in order to help sell to customers.

Goals and Objectives Achieved

The following four points were the IWC's goals for the grant cycle, and each goal was set to measure the amount of success that the IWC had with both the grant projects as well as the overall growth and success in the Idaho wine industry.

- Increase in Idaho wine sales and increase in market share of this specialty crop within the state.
- Increase in website traffic
- Increase in media exposure
- Increase in Social Media Traffic

The first goal, to increase the market share of Idaho wine in the state, was set as an overall measure of the sales of Idaho wine from tasting rooms, retail outlets and distributors. The IWC met with the Idaho State Tax Commission to set up a system that made sense for recording each quarter's numbers as reported by the wineries. All of the wineries, breweries, distilleries, retail shops, distributors, etc., report their sales to the Tax Commission, and in order to get the most accurate numbers possible for the purpose of understanding the market share for Idaho wine sold only in comparison with all other wine sold within the state, the Tax Commission agreed to separate the reports. At the end of each quarter, the Idaho Tax Commission sends the IWC numbers for Total Gallons Sold by All Entities, Total Gallons Sold by Idaho Wineries, Total Gallons Sold by Idaho Wineries to In-State Distributors, and Total Shipped to Out of State Distributors. With this information, the IWC is able to calculate the total number of cases of wine sold in the state per quarter, along with the total number of specifically Idaho wine sold in the state per quarter. The goal was to reach 8% market share in 2013. Each quarter the numbers received from the Tax Commission alter the market share number, at one point the market share reached 7.34% to come close to the goal of 8%. At the end of 2013, the market share was 5.86%. Although this was short of the goal for

2013, the market share was at 5.95% in 2011 and dipped to 3.82% in 2012. After this dip, it is positive to be back up to 2011 levels. By the end of the third quarter 2014, the market share was at 8.52%.

Measuring the website traffic was a very effective way to determine the increase in exposure. Each month the State of Idaho sends out website analytic statistics captured for those websites that are hosted on the state server. The website traffic was steadily increasing throughout the year. The downtown Boise banners were placed June 1-July 1 and the website analytics showed an increase of almost 1,000 unique visitors between May and June going from 5,266 to 6,261. The goal of averaging 5,000 average unique visitors per month has been met and by the end of November, the average for the year had reached 5,449 unique visitors.

The IWC had high hopes to replicate the number of media impressions received in 2012 of 400,000,000. This was quite a large goal since an article was picked up by USA Today and the Washington Post to drastically increase the number of media impressions in 2012. Although the Idaho wine industry has received a large number of media impressions, the goal has not been reached. To date, the total number of media impressions is 126,004,966. Even without a story being ran by USA Today, the total impressions for the Idaho wine industry were quite large. Red Sky PR tracked each of the media hits every month to prepare reports totaling the impressions each month and therefore giving the IWC an overall total for the year. Even without reaching the goal of 400,000,000 wasn't met, 126,004,966 impressions is still a number that the IWC is proud of.

On the social media front, the initial goal was to reach 800 likes on Facebook and to increase the Twitter followers to 1,600. The initial goals had been reached by the first reporting period, so the IWC moved on to the 2014 goals for 1,000 Facebook likes and 2,000 Twitter followers, both of these goals were also surpassed. At the end of the 2013, the social media numbers were 1,198 Facebook likes and 2,470 Twitter followers.

Beneficiaries

The IWC is an Idaho state agency with the purpose to market and promote all of Idaho's 50 wineries and 56 vineyards. The key point of raising awareness for the Idaho wine industry is the overall goal for the IWC. Since the purpose of the grant project was to increase the awareness and consumption of Idaho wine and wine grape products throughout Idaho by increasing local advertisements and promotions, the grant purpose was in line with the overall goal of the IWC and benefits all of Idaho's wineries and vineyards. The IWC is the information and education source for Idaho wine and by increasing the resources available to the over 100 members of the Idaho wine industry, and raising more awareness, the IWC is working to grow the industry overall. The biggest data point that concerns the IWC members is the market share number. The higher the market share number, the more Idaho wine that is being consumed in the state. As more wine is consumed, the more demand there will be for product which in turn makes for higher demand for grapes to be planted and therefore grows all aspects of the industry.

Lessons Learned

Throughout the grant process, the IWC was fortunate to not experience any delays or interruptions. Getting accurate reports from the Tax Commissions took some management to ensure the market share numbers were accurate, however with the ongoing conversations, everything was worked out.

Although the grant application was submitted with numbers that had been researched by several different outlets and with the knowledge of previous experience, there were certain times when unexpected costs arose and line items had to be adjusted. The costs for the printing of the downtown Boise street banners were higher than anticipated due to unforeseen design and layout issues. To balance the extra expenses within the total grant funds awarded, costs were saved in advertising by negotiating lower prices.

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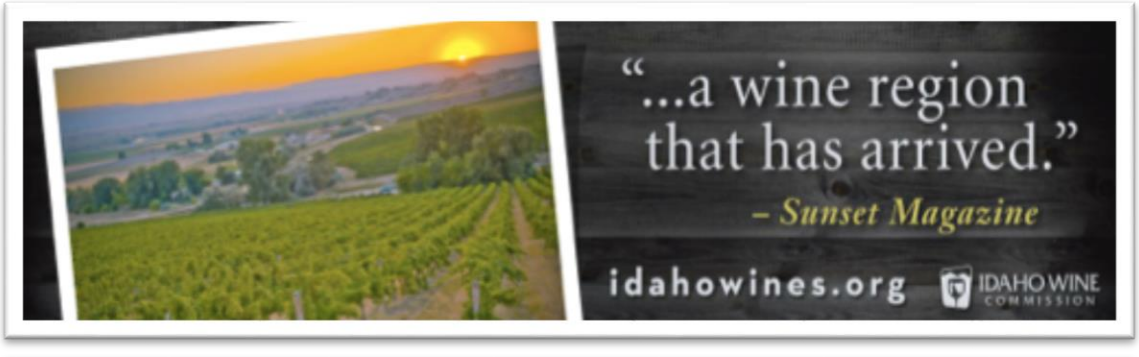
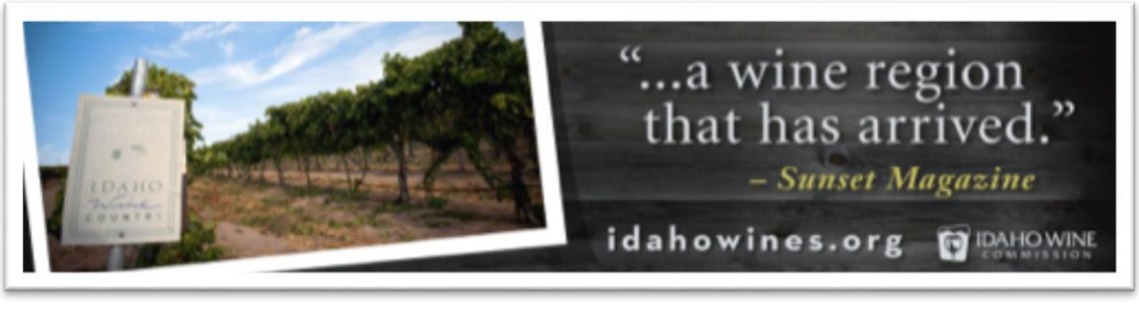
Additional Information

Below are examples of several of the ads that were placed with the various outlets along with images of the collateral for the billboards and street banners.





Developing an Economic Threshold for Twospotted Spider Mites in Hop

Subrecipient
Idaho Hop Commission

Project Summary
Twospotted spider mite generally is the most serious arthropod pest affecting hops production, requiring costly annual scouting and control efforts. Twospotted spider mite damages the plant by feeding on the foliage and cones; infestations of either can result in economic damage. Spider mite feeding on hop foliage can reduce photosynthetic capacity resulting in reduced yields. Severe infestations can completely defoliate plants. Mite feeding on hop cones results in dry, discolored cones that shatter easily, reducing both quality and quantity of yield. Contamination of cones by mites and mite webbing also reduces yield quality. Five to eight spider mite generations per year occur in the hop-growing region of southern Idaho, requiring two to four pesticide applications per season to maintain the pest below economically damaging levels. As a result, development of resistance to miticides has been a common problem in hop management since the 1950's due to the high susceptibility of the crop, long growing season, difficulty in obtaining good spray coverage due to dense foliage, and a conducive overwintering environment.

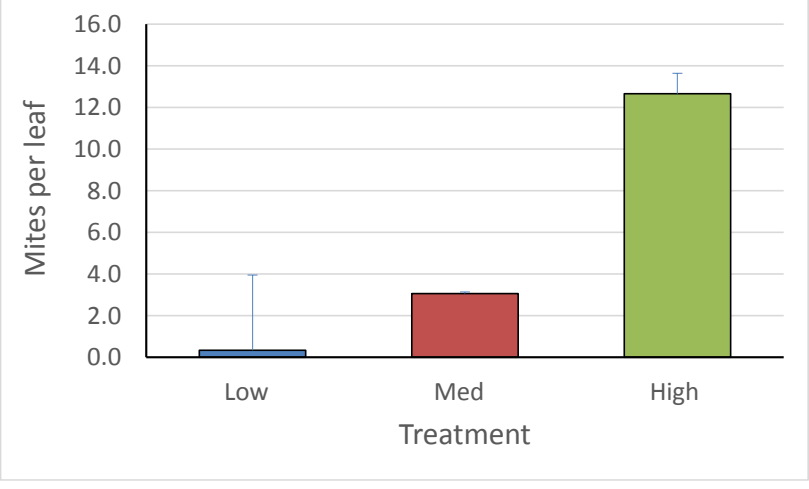
Although economic thresholds are the backbone of a sound integrated approach to pest management, no empirically-derived economic injury level exists for spider mites on hops: only a nominal or provisional economic threshold of 5–10 spider mites per leaf exists. This threshold was established by Strong and Croft (1995) for use in their studies, but no supporting evidence for that threshold was provided. In addition, this threshold did not address the issue of spider mite infestations in hop cones. Studies by Weihrauch (2005) conducted in European hops and Barbour (2005) in US hops indicate that hop plants may withstand much higher numbers of spider mites per leaf and cone without suffering significant yield loss. This project proposes to quantify the relationship between the level of twospotted spider mites on hop leaves and on cones with yield loss and then to calculate an economic threshold for spider mites in hops produced in the Pacific Northwest. Development of integrated pest management approaches for twospotted spider mite is listed by the hop industry as a critical need in the Pest Management Strategic Plan for Hops in Oregon, Washington and Idaho (DeFrancesco et. al 2008). This proposal directly addresses that need.

Project Approach
The Idaho Hop Commission worked collaboratiely with the University of Idaho Specialty Crops IPM program at the Southwestern Research and Extension Center in Parma, ID, to conduct replicated field experiments that would establish an economic threshold for twospotted spider mites in hop. This goal was to be accomplihed first, quantifying the relationship between spider mite infestation level on hop leaves and on hop cones with yield loss in hops, and then, using results of those analyses (hop yield loss per mite) together with current information on spider mite control costs (dollars/acre), hop value (dollars/pound) and yield (pounds/ acre), calculate an economic threshold for twospotted spider mite in hops. Detailed procedures are provided in the original proposal.

In 2014, spider mite numbers per plot for 2013 were analyzed and treatment differences in numbers of spider mites per leaf existed in pesticide treated plots, with numbers in untreated plots (high spider mite

level) briefly averaging about 13 per leaf (fig. 1). These numbers were not sufficiently high to result in yield loss. The hop yard has been prepared for activities associated with this and other experiments to be performed in 2014: the hop yard has been cultivated and the Idaho Hops Commission has set back the hops in preparation for stringing and training of hops in mid-late May. The drip irrigation system has been installed and drip tubing will be laid out immediately after stringing.

Figure 1. Mean number of spider mites per leaf on high, medium and low spider mite level plots in 2013.



The University provided an initial oral report of progress to the Idaho Hop Commission on 15 October, and a final report for 2013 on 10 December 2013.

A pyrethroid insecticide was applied in June 2014 as per the original proposal to increase spider mite numbers. Treatment applications and mite counts were collected as per the proposal protocol. Spider mite numbers per plot for 2014 currently are being analyzed, but preliminary counts indicate that mite populations were very low and treatment effects, therefore, are unlikely and will not be not sufficiently high to result in yield loss. The hop yard will be prepared for activities associated with this and other experiments to be performed in 2015: the hop yard has been harvested will be prepared in the spring of 2015 for additional experiments in the summer of 2015.

Research results were presented to University and USDA scientists, and to hop industry clientele attending the annual joint meeting of the Hop Research Council and the Hop Growers of America, 21 January 2015, San Diego, CA. Title: Development of Hop Integrated Pest management Strategies, Author/presenter: J. D. Barbour, Number attending: approximately 40. The University provided an initial oral report of progress for 2014 to the Idaho Hop Commission on 20 Oct. 2014, and a final report for 2104 will be submitted by the end of December 2014.

The Idaho Hop Commission web site is current off line, and because the results to date have been inconclusive, there are not peer-reviewed publications as a result of this research. Written reports have been sent from the University to the Idaho Hop Commission as well as to the Hop Research Council. Oral reports of the research have been delivered to growers and other industry representatives attending Idaho Hop Commission meetings held in the summer, fall and winter of 2014 (approximately 9 attendees at each meeting), and the Hop Research Council meetings held in August of 2014 (approximately 24 attendees) and January of 2015 (see above).

Goals and Outcomes Achieved

The goals of this project were 1) to quantify the relationship between spider mite infestation level and yield loss in hops and then 2) to relate yield loss due to spider mite infestation, production cost, spider mite control costs and crop value to calculate an economic injury level for spider mite in hops. However in both years of this, study spider mite populations capable of reducing quality and quantity of hop cones failed to develop and we were, therefore, unable to achieve either of our stated goals. Given the historical annual occurrence of damaging spider mite populations on hops in southwest Idaho, this outcome could not have been reasonably foreseen.

Research findings were presented to Idaho hop growers the annual meetings of the Idaho Hop Commission (Dec. 7, 2015) and to regional hop growers and hop industry personnel (brewing companies, hop buyers, crop management specialists, etc.) attending the annual summer meeting of the Hop Research Council (Aug. 6, 2015) and annual combined winter meeting of the Hop Growers of America and the Hop Research Council (Jan. 20, 2016). However I was unable to make a presentation to researchers and extension educators attending the annual meetings of the Entomological Society of America.

The total number of stakeholders to whom this information was disseminated was 95: 23 at the annual meeting of the Idaho Hop Commission, 34 at the annual summer meeting of the Hop Research Council/ Hop Growers of America meeting and 38 at the annual winter meeting of the Hop Research Council.

Project leaders used the attendance lists at meetings of the Idaho Hop Commission, and the joint meetings of the Hop Research Council/Hop Growers of America to measure the number of organizations and individuals directly receiving results. They also measured organizations and individuals receiving results indirectly by tracking email, phone and written requests for publications resulting from this research, and by tracking hits on websites where results of this research is posted.

Beneficiaries

Development of an economic threshold would benefit hop growers and other hop industry segments by enabling management of spider mites consistent with integrated pest management principles and provide a quantitative safeguard against either unacceptable crop and economic loss resulting from too few or incorrectly timed miticide applications, or avoidable economic losses resulting directly from over treatment with miticides and indirectly from rapid development of resistance and destruction of natural enemies. The total number of stakeholders to whom this information was disseminated was 95: 23 at the annual meeting of the Idaho Hop Commission, 34 at the annual summer meeting of the Hop Research Council/ Hop Growers of America meeting and 38 at the annual winter meeting of the Hop Research Council.

Lessons Learned

One of the question to be asked her is whether or not the lack of high spider mite populations on hops at the Parma Res. & Ext. Center hop yard is a statistical anomaly or results from some biological or abiotic condition of the hop yard itself, such as high overwintering mortality of spider mites due to the presence of natural enemies (spider mite predators or pathogens) or unsuitable overwintering habitat. The hop

varieties grown in the Research hop Yard, Super Galena and Newport, are not known to be resistant to spider mites.

It might also be prudent to monitor and apply initial low-mite treatments to multiple fields including grower fields, then finally selecting for the study the field that develops sufficiently high might populations. Although this approach would greatly reduce the chances of failure due to low spider mite populations, it also would greatly increase the cost of the project due to the need to prepare, monitor and treat several fields prior to finally selecting one with ample pest populations.

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Additional Information

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Plant Something: Awareness Campaign for Idaho-Grown Products

Subrecipient
Idaho Nursery and Landscape Association

Project Summary
The project purpose focused on the importance of planting for the public's health both in what plants do for them through air quality and how planting promotes their own personal health. Educating the public about the value of locally-produced landscape plants will have a significant impact on the long term success of the Idaho nursery industry. INLA was uniquely positioned to promote and encourage the use of Idaho-grown landscape plants. The broad-based marketing effort for planting Idaho nursery products was promoted to the public using media print, public events and the Internet. The message reached the broadest audience across geographical and generational ranges, positively impacting the sale for retail and wholesale markets. The expansion of the *Plant Something* marketing campaign message which included billboards, regional media print and an expansion of the Planting Idaho website which featured the message of *Don't Just Stand There: Plant Something*, with a *Gardening for Health* theme.

The need for an increase in these efforts is critical as the nursery industry is affected by the continued downturn in the economy. Increasing the long-term sustainability of the Idaho nursery industry was a priority, but the project also provided the opportunity to teach people the importance of planting things that will help with basic health needs. Using three main messages on the magazine cover and on billboards: Gardening Grows Health; Gardening Keeps You Active; and Gardening Reduces Stress, INLA was able to give the public something to think about that would be very simple for them to do while realizing significant benefits back to them.

A Specialty Crop Grant in 2012 allowed marketing material to be produced for retail nurseries throughout the state to carry the message of *Plant Something* in the spring of 2012; this 2013 grant enabled the INLA to take the next step which was to reach out to the public that may not shop at a retail nursery.

Project Approach
The activities performed for this grant were as follows:

- Introduced to the Green Industry through promotion at Idaho's only green industry event – the Idaho Horticulture Expo in January 2013. IHE had over 1,100 attendees that saw the Gardening for Health messages. The response was very favorable to the colorful artwork and message. Orders were taken for the banners that will have the same message that would be delivered in March.
- In February letters were distributed to 278 Idaho cities and counties for the Arbor Day grant program displaying the Plant Something message.
- In April 2013, 6,000 magazines were printed, with the cover being the three Gardening for Health messages. Inside the magazine were articles with the health messages. These magazines were distributed throughout Idaho and upon request. Distribution locations included the Boise Flower and Garden show, Bonneville County's Thaw and Awe event, the University of Idaho Bonner County Extension office, the University of Idaho's Boundary County office, the Sawtooth Botanical Garden, the Idaho Botanical Gardens, and BYU-Idaho (for visitors to the display garden). Billboards were located throughout Idaho delivering the Gardening for Health message. There were 28 print billboards placed having 987,625 weekly impressions as reported in the usage statistics.
- Bumper stickers were printed with the slogan of *Don't Just Stand There: Plant Something* and given out at the Boise Flower and Garden Show. They have also been placed in INLA membership packets

and given out at various events. The remainder will be given out at the upcoming Idaho Horticulture Expo in January 2014.

- Listed on the billboards was the website address of www.plantingidaho.org
- The Planting Idaho website was updated to give web browsers the opportunity to learn more about how plants benefit their health. After the billboards were placed in May, the total hits in June were 114,744.
- Banners were produced that were miniature versions of the billboards. These banners were made with fabric that will last 3-4 years. 150 banners were sent to retail nursery/garden centers throughout Idaho to display in their businesses. As INLA Executive Director Ann Bates traveled throughout the state for various events, she noted them hanging in displays both indoors and outdoors. Best of all, they were in every location she visited! Many of them were also posted on the INLA Facebook page and received many "likes".
- Print ads were placed in the summer and fall issues of a regional magazine *Zone 4*. The magazine has a circulation of 11,000 and 1,500 website hits per month.

Project Partners

- Many project partners contributed by helping to distribute the Gardening for Health message. The Idaho Department of Lands allowed the message to be used on the information sent to communities in Idaho. The Idaho Botanical Gardens, Sawtooth Botanical Gardens and BYU Idaho helped to carry the message by distributing the magazine to their attendees. University of Idaho's Extension offices shared the magazine in their offices.

Goals and Outcomes Achieved

The goal was to reach out to people who do not frequent local garden centers in an effort to educate them on the importance of Gardening for Health and why planting and buying locally grown plants is so important.

Activities Completed

- Introduced to the Green Industry through promotion at the Idaho Horticulture Expo in January 2013. A survey was given to attendees of the event.
- Idaho Communities were informed of the message.
- Printing of 6,000 whose cover was the three Gardening for Health messages. Distributed throughout Idaho.
- Billboards were located throughout Idaho delivering the Gardening for Health message. They included the website address of www.plantingidaho.org
- Bumper stickers were printed and given out at various events.
- The Planting Idaho website was updated to give web browsers the opportunity to learn more about how plants benefit their health.
- Banners were produced that were miniature versions of the billboards and distributed to retail nurseries and garden centers.
- Print ads were placed in the summer and fall issues of a regional magazine *Zone 4*. The magazine has a circulation of 11,000 and 1,500 website hits per month.

Long Term Outcome

The long term outcome for this project is that retail nurseries and garden centers continue to sell more plant material. The trickle down affect that it has is that growers of Idaho products also sell more

product. The garden centers will continue to promote the message with the banners that they display. Consumers will be directed to the plantingidaho.org website in 2014. All segments of the industry have embraced the slogans and used them in their businesses. Additionally, increased demand for products, both wholesale and retail, increases employment opportunities for Idaho citizens.

Comparison of Actual Accomplishments for this Reporting Period

The last quarter was spent making more updates to the plantingidaho.org website. Features were added that would help the web surfer find the products and services they were looking for with one easy search. Also added was a page specific to the Gardening with Health benefits that gives the surfer other links to stories about how planting is good for your health. The TV video that Arizona had done "Imagine a World without Trees" was also placed on the website. The final remaining funds left were used to purchase bags with the *Plant Something* logo that will be given out at the 2014 Idaho Horticulture Expo.

Baseline Data and Set Targets

- At the Idaho Hort Expo, 234 people participated in a survey that asked just one question. "Before this show had you ever seen the Gardening with Health" message? 100% of those surveyed said no, they hadn't seen it before. A follow up survey was conducted in November via Constant Contact to the same people who did the survey in January 2013. The open and answer rate for the survey was 37%. The survey had two questions, and the first was "Did you see the Gardening for Health banners at the IHE?" INLA wanted to see how many of those that initially said no remembered. 54% said yes, they remembered seeing the banners. 42% said no. Comments included: "Great concept!"; "this was too long ago. Don't remember them especially"; "Very eye catching, love the theme"; "I thought that it was an excellent way to plant that in the minds of those attending to do more gardening for our own benefit as well".
- The second question was "The Gardening for Health message was placed on billboards this spring. Did you see one of the billboards?" 34% said yes, and 61% said no. Comments included: "As I traveled through the area I did see billboards and was a good reminder to me as I am sure it was for all who saw it."; "This was very well done."; "too long ago to remember, not sure".
- Billboards were located throughout Idaho delivering the Gardening for Health message. There were 28 print billboards placed having a weekly impressions for the billboards at 987,625. A follow up survey was sent to the attendees of the Boise Flower & Garden Show. A total of 664 people were surveyed at the event in the INLA booth area. They were asked "Before this show had you ever seen the Gardening for Health message". 35% of the respondents said yes and 65% said no. This was a bit confusing because this even was the first time the message had been presented. After asking several attendees, they said they saw it on the banner that was in the hallway and on the magazine cover that was handed out at the front door.
- A follow up survey was sent in November 2013 to these same attendees via Constant Contact to 652 email addresses. The survey contained two questions and 27% of recipients opened the survey and answered. The first question was "The Gardening for Health message was placed on billboards throughout the state. Did you see one this spring?" 40% of the respondents said yes, they had seen the billboards. 60% said no. Comments included: "I saw them in three locations in the treasure valley"; "I was surprised at how many times I saw your billboards. I tried to count how many I saw but lost count."; "I cannot recall if I saw the billboards or not. This question would be better asked a few months ago."; "Thanks for bringing this to my attention".
- The second question was "The Gardening for Health message was on smaller banners and displayed at retail nurseries/garden centers. Did you see the message while shopping this spring?"45% said yes,

they had seen the banners. 55% said no. Comments included: "I saw them at maybe six nurseries and one Lowes store."; "I enjoy going to a lot of garden centers. I saw your small banners at several of them."; "I don't remember, that was 6 months ago"; "When I am in the nursery, I am totally absorbed with the plants".

- INLA sent 150 banners out to 47 different businesses with the same Gardening for Health message that was on the billboards. The final survey was conducted via Constant Contact and sent to the retailers who had received the banners in the spring. Of those that received the survey, 27% responded. There were two questions on this survey, and the first question was "The Gardening for Health message was placed on billboards throughout the state. Did you see the billboards this spring?" 86% said yes, they had seen the billboards, 14% said no. There were no comments. The second question was "This spring you were sent banners with the Gardening for Health message. Did you display them? 100% said yes, they had displayed the banners.
- The Planting Idaho website was updated to give web browsers the opportunity to learn more about how plants benefit their health. After the billboards were placed in May, the total hits to the website in June were 114,744.In January this website had 4,745 hits. Other totals from the June usage statistics report for plantingidaho.org included 4,858 hits (compared to 982 in January) and 60,699 pages (compared to 1,832 in January).
- INLA surveyed member retail nurseries/garden centers to report plant sales during same month cycles to measure the effectiveness of the promotion. Idaho growers were also surveyed to determine increases in sales during the similar month cycles. The survey was sent via an email to target specific businesses in order to make sure that information was received from all over the state and from different sized businesses.
- INLA predicted that Idaho nursery sales will be increased by 5-7% during the planting season of the promotion. Growers' sales would increase due to the demand by the retailers for more products. Retail sales will increase due to the demand from the consumer for products that promote health benefits. The Idaho growers had an average increase of 17%. The retail nurseries/garden centers had an average increase of 8%. Both figures were above what was predicted. Comments included: "We had a slow start to the season and feel we would have increased even more without the wet spring"; "Sales were the best they have been in several years".

Beneficiaries

The groups that benefited from this project were far reaching. There were 1,839 nursery licenses issued in 2013. Many of the licensees do more than just one segment of the industry, however this is the breakdown: Nurseries 307; Retail 486; Sod Growers 83; Florist 310; Greenhouse Growers 180; Grocery Store 217; Landscape 624; Christmas Trees 88; and other is 417. Each of the segments was touched in some way by the project. Idaho growers sold more products and were able to replant for the upcoming years, retail nurseries/garden centers sold more product and were able to convey the Gardening for Health message to their customers and the consumer was educated through the billboards and website about the value of the message. Landscape contractors were able to use the message to encourage customers to have more plants included in their designs and installations. Many of the comments that INLA received were that the *Plant Something* message needs to continue. The national campaign now has 11 states and 1 province participating in carrying the *Plant Something* message – each in a different way, but all with the same message.

Lessons Learned

This project went very well. Introducing it to the attendees at the Idaho Hort Expo in January kicked off the campaign. Next, the attendees of the Boise Flower & Garden Show in March 2013 were introduced to the message, followed by the billboard placement, then the banners going up in retail nurseries/garden centers in April/May. The artwork was very colorful and simple. One lesson learned was that INLA waited too long to send follow up surveys. It should have been done in June or July instead. The INLA Executive Director chose to wait because she wanted the gardening season to be over in order to gain a better idea of the campaign's long term affect. Although the survey numbers were not unfavorable, it would have been preferable to have a longer lasting benefit to the Gardening for Health message. Many comments were made that they recognize the Plant Something plant stake logo, which is truly the predominant message to the campaign: *Don't Just Stand There: Plant Something.*

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Novel Control Strategy for Pale Cyst Nematode, Lesion Nematode, and Fungal Pathogen of Potato

Subrecipient
Idaho Potato Commission

Project Summary
The pale cyst nematode (PCN), *Globodera pallida*, first detected in the U.S. in 2006, is currently found in this country only in the state of Idaho. Extensive Idaho potato acreage has been quarantined due to presence of PCN, and eradication efforts are underway using currently available chemical fumigants. Thus, PCN represents a major cost and challenge to the Idaho potato indusry. As potato acreage becomes cleared for renewed planting of potato following PCN eradication efforts, it will be critical to ensure that any possible residual (undetected) nematodes are stopped from infecting plants and causing a nematode population increase. The lesion nematode (*Pratylenchus* spp.), unlike PCN, is relatively ubiquitous in Idaho potato fields. These nematodes reduce yields indirectly by increasing stress and weakening the plants, thus making potatoes more susceptible to fungal and bacterial diseases. This project optimized the use of beneficial nematode-attacking fungi as protectant seedpiece coatings for potato, to protect the plants from attack by these damaging nematodes. These same beneficial fungi also provided protection from other potato pathogens including *Fusarium* and *Rhizoctonia*. The combination of environmentally-friendly plant protection and novel formulation technology enhanced the health and helped maintain the good market reputation of Idaho potatoes.
The use of beneficial fungi that attack PCN and protect potato seedlings provided a biologically-based control strategy, since these nematode-parasitic fungi were able to colonize plant roots, and from there attack and destroy juvenile nematodes in the rhizosphere as well as nearby PCN eggs in cysts. IPC has isolated and identified strains of known nematode cyst- and larvae-parasitizing fungi, including *Plectosphaerella* sp. and *Trichoderma harzianum.* In numerous publications, IPC had characterized the biocontrol efficacy, soil activity, and rhizosphere competence of *T. harzianum*. In addition, IPC developed and published novel and effective methods to formulate biocontrol fungi for soil application, for enhanced survival and growth characteristics (Knudsen et al., Appl. Env. Microbiol. 57:2864-2867). The species *Plectosphaerella cucumerina* has achieved a 60% reduction of field populations of PCN in Australia when applied as a pellet formulation (Jacobs et al, Mycol. Res. 107:47-56), and IPC has observed similar results in growth chamber experiments using conidial suspensions of *P. cucumerina* (Worapong & Dandurand, unpublished). IPC hypothesized that formulating and placing the biocontrol fungi directly on potato seedpieces, from where they can colonize and protect the potato plant rhizosphere, would enhance this nematicidal activity at the most important location, the potato root surface.

Project Approach
In this project, the Idaho Potato Commission (IPC) adapted and tested the above methods and organisms for application to potato seedpieces prior to planting, for protection against invasive pathogens, particularly PCN.

Graduate student participation and training: M.S. graduate research assistant Jn. Bertrand Contina started work on this project in May of 2014, under the direction of principal investigators Guy Knudsen (major professor) and Louise-Marie Dandurand (graduate committee member). Mr. Contina's thesis research is entirely focused on this project, and will be completed in Spring of 2016.

Culture and propagation of pathogenic fungi and nematodes: Cultures of *R. solani*, *F. sambucinum*, and *Pratylenchus* were obtained from colleagues. *Pratylenchus* culture populations were amplified on susceptible hosts (potato, tomato) in the greenhouse to provide sufficient inoculum for replicated experiments. Also during this time period, populations of PCN cysts were continually increased in L.M. Dandurand's program, to provide sufficient numbers of PCN for experiments. This work resulted in large numbers of cysts being made available for experimental use.

Formulation technology for ecofriendly control agents. Several experiments focused on potentially patentable formulation methods to enhance the survival, efficacy, and shelf-life of selected fungal and bacterial agents. The methods are not discussed in detail here due to intellectual property considerations, but included approaches to reduce adverse effects of dessication and rehydration (osmoprotectants), added microbial growth stimulants, additives to improve competive ability of the agents, and effective combinations of agents and other formulation components. However, a simple and inexpensive delivery system consisting of the respective beneficial fungi cultivated on sterile oat kernels proved to be consistently effective.

Laboratory and greenhouse evaluation of biocontrol agents. Potential biocontrol agents were evaluated in replicated laboratory and greenhouse trials.

Effect of *Plectosphaerella cucumerina* on PCN egg persistence and hatching (preliminary results). In greenhouse experiments, clay pots were inoculated with 2.5 PCN eggs/g of soil, then planted with potato, in pots with either untreated soil, or soil to which the biocontrol agent *Plectosphaerella cucumerina* was added (*P. cucumerina* is our isolate from Idaho potato field soil). After 16 wk, the number of eggs remaining in initial cysts were counted, and hatching was determined. Results were as follows:

Treatment	Eggs/g soil @ 16 wk	% hatch
Control	0.42	65
P. cucumerina	0.60	15

Numbers of eggs per gram of soil did not differ significantly between treatments, however addition of *P. cucumerina* significantly reduced percent hatch of the eggs. The experiment was repeated with similar results.

Reduction of PCN in potato roots treated with the bacterial agent *Delftia tsuruhatensis* (preliminary results). The nematode antagonist *Delftia* was isolated by us from Idaho field soil. Potato ('Russet Burbank') seedling roots were either dipped into suspensions of *Delftia* (10^7 cfu/ml) or untreated, then planted into pots. After 6 wk, numbers of PCN (all life stages that were present) in roots were counted. Results were as follows:

Treatment	Nematodes per root
Control	62
Delftia	1

Treatment with *Delftia* significantly reduced numbers of nematodes in roots.

Evaluation of *Trichoderma harzianum* as a protectant potato seedpiece coating against *Fusarium* and *Rhizoctonia*. *Trichoderma harzianum* ThzID1 (field isolate from northern Idaho) was formulated by growing on sterile oats. *Fusarium solani* was formulated similarly. Potato seedpieces ('Russet Burbank') were placed in half-full pots of soil, and inoculated with the organisms separately, together, or uninoculated (control) (Fig. 1). Pots were then filled with soil and plants were allowed to grow in the greenhouse. After 40 days, plant growth and disease were evaluated.

Fig. 1. Potato seedpieces inoculated with *T. harzianum* (green colored oat kernels) and *F. solani* (pale-pink kernels). Other treatments were *T. harzianum* alone, *F. solani* alone, or untreated control.

Preliminary analysis of results indicated that *F. solani* significantly reduced mean root length, stem length, and biomass compared to controls, and increased disease compared to controls. *T. harzianum* alone did not significantly affect any of the above parameters. However, *T. harzianum* did not reduce the adverse effects of *F. solani*, and it is possible that this formulation (oat kernels) may have provided an additional nutrient source for the pathogen. The experiment is being further analyzed and will be repeated, and will then be conducted with modifications of the formulation. Parallel experiments with *Rhizoctonia solani* were also initiated.

Fig. 2. Treatment with *F. solani* alone (left) and *T. harzianum* alone (right).

Trichoderma harzianum strains ThzID1 and ThzID1-M3 transformed to express green fluorescent protein (GFP) (Fig. 3), were maintained on *Trichoderma* selective medium (TSM) (Elad, 1981) for 2 weeks. TSM contained the following components (g/liter distilled water): MgSO4.7H2O, 0.2; K2HPO4, 0.9; NH4NO3, 1.0; glucose, 3.0; chloramphenicol, 0.25; rose Bengal, 0.15; streptomycin sulfate, 0.025 and agar, 20. *Fusarium solani* and *Rhizoctonia solani* were maintained on potato dextrose agar (PDA) plates for 2 weeks. PDA contained the following components (g/liter distilled water): potato dextrose broth, 24; agar, 17; streptomycin sulfate,
0.025. The fungi were allowed to grow in 500-ml Erlenmeyer flasks with 300 g of oats and 110 ml distilled water, which was first autoclaved for 1 hr. Each flask was inoculated with five fungal plugs of 5 mm diameter from media plates. Flasks were incubated at 25°C for 20 days, with periodic mixing. Potato tubers, 'Russet Burbank' cultivar, were surfaced-sterilized for 10 min. in a 10% bleach solution, rinsed in sterile distilled water, and seed dormancy was broken after 5 days. The experiment was carried out in a 2:1 mixture of sand and silt loam soil that was first autoclaved for 2 hr. 15-cm-diameter clay pots containing 1.5 kg of soil were used.

Two set of separate experiments were used for the biocontrol of *F. solani* and *R. solani* by *T. harzianum* strain ThzID1, oat formulation in the amount of 5 g was mixed uniformly with the soil prior the planting of potato tubers, according to treatments: Control, ThzID1, *F. solani* or *R. solani* and ThzID1 mixed together with *F. solani* or *R. solani*. Treatments were replicated five times and both experiments repeated twice. Pots were placed on a greenhouse bench and maintained at 21-23 ºC, 60% relative humidity, and 15:9-hr light: dark photoperiod and were watered daily and fertilized three times a week. Treatments were evaluated 40 days. All watering and fertilizing was terminated 5 days earlier in order to let the soil dry. Roots were washed in distilled water and disease was rated. Root damage was categorized numerically (Carling and Leiner, 1990) as follows: 0 = no damage, no lesions or rot; 1 = minor damage, one to several lesions less than 5 mm long; 2 = intermediate damage, lesions greater than 5 mm log, some roots
girdled, and much dead tissue; 3 = major damage, lesions large, and most root tissue dead; 4 = all roots rotted and dead, or no roots present. Additionally, mean root weight and length were determined for each treatment.

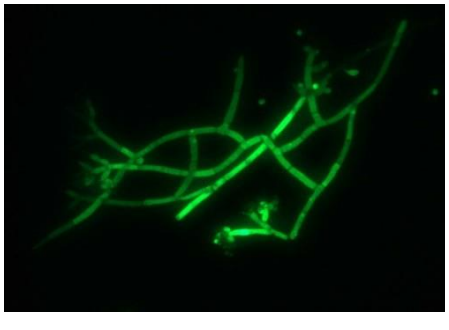

Fig. 3. *T. harzianum* strain ThzID1-M3 with Green Fluorescent Protein (GFP) expression under 550 nm wavelength. J. B. Contina photo.

Fig. 4. *T. harzianum* colonizing potato root.

T. harzianum strain ThzID1 effectively colonized potato roots (Fig. 4), but did not perform well in reducing the level of root infection by *F. solani* in potato. Root evaluation showed 100% of potato plants in combination with *T. harzianum* were severely rotted by *F. solani*, as shown in Fig. 5. However, *T. harzianum* strain ThzID1 was been able to reduce the level of root infection by *R. solani* in potato by 57%, as shown in Fig. 6.

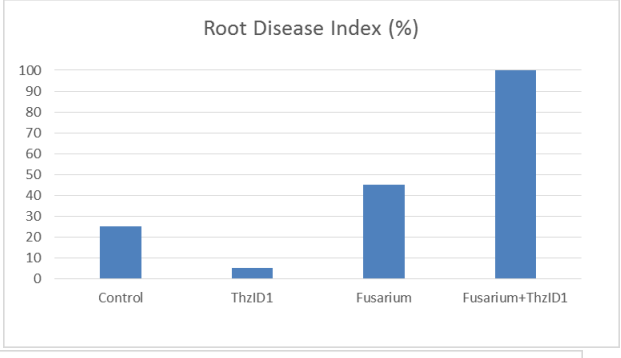

Fig. 5. *Trichoderma* vs*. Fusarium*

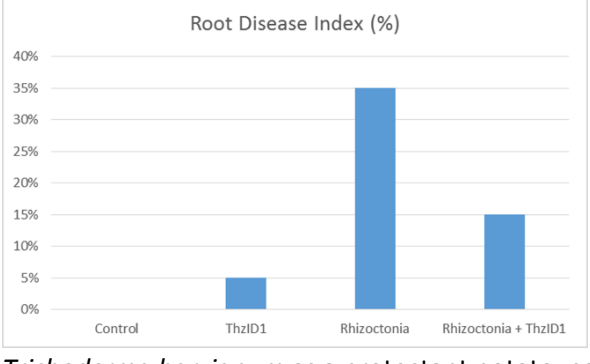

Fig. 6. *Trichoderma* vs*. Rhizoctonia* Evaluation of *Trichoderma harzianum* as a protectant potato seedpiece coating against PCN. Two biocontrol experiments on the pale cyst nematode with *T. harzianum* strain ThzID1 and ThzID1-M3 were performed. Ten cysts, previously sterilized in 1% sodium hypochlorite and hydrated for 24 hr, were inserted inside a nylon bag and placed inside the pot below potato tuber. Treatments were, as follows: Control, ThzID1, PCN, and PCN together with ThzID1. Treatments were replicated five times and both experiments repeated twice. Treatment were evaluated 50 days. Root samples were collected, washed in distilled water and stained in acid fuchsin dye for counting nematode life stage (J2, J3, J4 and adult nematodes) inside the root system. Other root samples were sterilized in 1% Sodium hypochlorite, washed thoroughly in sterile distilled, and plated in TSM for ThzID1 root colonization evaluation. Soil samples were collected for cyst extraction. Cyst colonization experiment was conducted using potato dextrose agar (PDA) and water agar as growth medium for ThzID1-M3 applied in conidial suspension at different level of concentrations. 10 cysts were placed randomly in each medium and incubated for 10 days at room temperature. Observation of the cysts under compound microscopy was used to assess the level of colonization by *T. harzianum*.

ThzID1 reduced PCN infections in potato roots by 99%, as shown in Fig. 7, and was able to effectively colonize the potato root system. *T. harzianum* strain ThzID1-M3 was able to colonize the cyst surface (Fig. 8).

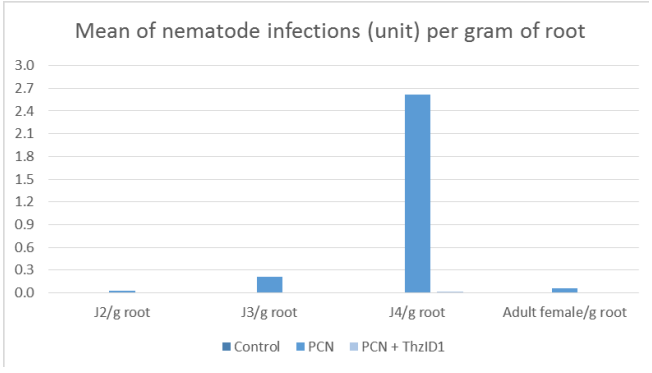

Fig. 7. Control of PCN by *T. harzianum*

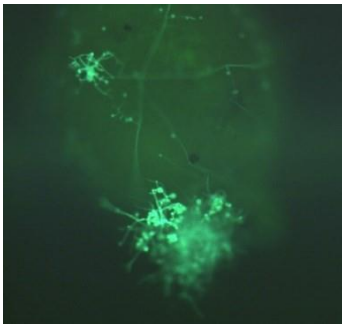

Fig. 8. Colonization of PCN cyst by *T. harzianum*

Evaluation of efficacy against *Pratylenchus* is still ongoing.

Goals and Outcomes Achieved

The overall project of evaluating and comparing biocontrol agents against these pathogens was accomplished, and baseline data were gathered to support further research. Evaluation of biocontrol agent efficacy against Fusarium, *Rhizoctonia*, and PCN was accomplished, however evaluation of efficacy against *Pratylenchus* is still ongoing.

In summary, *Trichoderma harzianum* formulations showed little potential for control of *Fusarium*, some potential for control of *Rhizoctonia*, and significant potential for control of *Globodera pallida*, the pale cyst nematode (PCN). Future efforts will focus on increasing and quantifying PCN control.

Additional goals that were achieved during the grant period include the following:

- One measurable outcome of this project was the adoption of this technology by one or more commercial potato growers, as a demonstration to support proof-of concept and to encourage adoption by other growers.

- In addition, measurable outcomes included research findings ~~be~~ presented in scientific research and extension publications, grower publications (e.g., Spudman), at national and regional meetings, for example American Phytopathological Society (APS), Society of Nematologists (SON), Idaho Association of Plant Pathology (IAPP), and at grower meetings (e.g., Idaho Potato Schools). Organizations that the project results reached included APS

- SON, IAPP, and Idaho Potato Commission (IPC). Measurement of individuals reached ~~will~~ included attendance figures from APS and SON meetings, IAPP annual meeting, and Idaho Potato Schools. Individual attendees at IAPP and Idaho Potato School sessions were

registered, and registration lists were used to measure actual numbers of individual growers, field agents, and others reached by these presentations.

- In addition, periodic conference calls were arranged with growers, typically groups of 15-30 individuals, for example a conference call was held in June 2012 with approximately 15 growers attending in which we presented a PCN research update. Initial reporting of research findings occurred by the end of the first project year, with full reports of results and conclusions at the end of the second year.

Beneficiaries

In the short term, the research community is benefitted by this work, and ongoing efforts will be of significant benefit to the entire Idaho potato industry once this approach reaches the implementation stage.

Experimental results have been presented at grower meetings (50 attendees), scientific meetings (100 attendees), and publications (disseminated to over 100 individuals, organizations) (see below under Additional Information). Additional publications will be forthcoming.

Lessons Learned

The goal of evaluating and comparing biocontrol agents against these pathogens was accomplished, and baseline data were gathered to support further research. The biocontrol fungus *Trichoderma harzianum* showed relativly little potential for control of *Fusarium*, but some potential for control of *Rhizoctonia*, and significant potential for control of *Globodera pallida*, the pale cyst nematode (PCN). Our future efforts will therefore focus on increasing and quantifying

PCN control. Relatively simple and inexpensive formulation methods (propagation on oat kernels) proved to be an effective method for this biocontrol fungus.

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Additional Information

The following presentations and publications resulted from this project:

- L.M. Dandurand presented results from this and related research to growers in her presentation "PCN & Its Relatives: History & Future Prospects", at the Idaho Potato School, Jan. 22, 2014.

-Knudsen, G.R., L.M. Dandurand, and J.B. Contina. 2015. Modeling trap crop and biocontrol agent effectiveness in management strategies for *Globodera pallida.* Ann. App. Biol. (in press).

-Knudsen, G.R., and L.M. Dandurand. 2014. Ecological complexity and the success of fungal biological control agents. Adv. Agric., vol. 2014, Article ID 542703, 11 p.

-Dandurand, L.M., and G.R. Knudsen. 2014. Soil health after fumigation. Potato Progress 14(12):2-4.

Approximately 500 attendees/stakeholders were recipients of the results presented at each event.

International Market Development for Idaho Potatoes

Subrecipient
Idaho Potato Commission

Project Summary
This project allowed the Idaho Potato Commission (IPC) to broaden awareness and increase competitiveness of the Idaho® potato in several regions across the globe.

In general, the United States Potato Board (USPB) has seen an increase in potato exports worldwide of 7 percent, year over year. The United States in its targeted markets has witnessed a slight decline in metric tons exported, but an increase of 16% in value over 2013. With the majority of U.S. potatoes being grown in Idaho, it is extremely important that the IPC continually support the potato industry by finding new markets and strengthening ties between Commission partners and Idaho growers/ processors. The awarded SCBG funds have supported international efforts and have allowed the Commission to aid the potato industry in Idaho in an increase of approximately 12% of sales in table-stock and a 25% in sales of dehydrated products in current markets, as well as the launching of the Idaho® potato in newly opened markets.

The funds received from the 2012 SCBG grant were used to build upon the educational activities and awareness programs funded by the 2011 SCBG. In 2011, many of the educationally focused promotional programs were developed and implemented in many of the markets open to fresh potato trade at the time, such as Malaysia, the border region of Mexico, and Puerto Rico. The 2013 grant funds were used to implement these adapted trainings and lessons learned into improved promotional programs and trade missions in some of the same regions, but also expanding into Central America and Hong Kong as well as newly opened markets, like Vietnam and the Philippines.

These funds enabled the Idaho Potato Commission to be in the markets where Idaho potatoes are being sold. The Commission's presence in the markets allows for loyal relationships to be built with the local buyers and distributors. Continued presence in the market and the Commission's hands-on approach to training, educating, and promoting Idaho potato products has been positively received in all the regions in which the Commission is active.

Project Approach
Through trade missions and market visits conducted in new markets such as Russia, Vietnam, Taiwan, and the Philippines, the Commission was able to introduce Idaho® potato products and Idaho growers and/or processors to keenly interested buyers and retailers in these new markets. A better understanding of these markets and regions has provided the Commission with information needed to develop product positioning and market entry strategies. Trade missions and market visits to recently opened markets like Panama, Columbia, El Salvador, and Guatemala have proven extremely beneficial for brand recognition as well as increased sales in these countries. Last, but certainly not least, having the support funds to be able to consistently visit markets where the Commission has groomed a good base of customers for Idaho potatoes has also been vital in maintaining and growing the relationships.

- Last year's market visit to Malaysia and spending quality time with two major buyers in Kuala Lumpur resulted in 3 extra containers of Idaho® potatoes for a "Giant at Giant" promotion and a new promotional program with a large distributor in Malaysia that added another 5 containers of Idaho® potatoes to their orders.
- The trade mission to Vietnam and Singapore resulted in the first two containers of Idaho® potatoes exported to Vietnam and has increased inquiries for further orders.
- Since the trade mission to Panama and Columbia, Idaho growers/processors have been consistently supplying potato products to those markets.
- A market visit to El Salvador in February resulted in seven truckloads of Burbank russets for a five-week long promotion supported by the IPC in El Salvador in March. The launch consisted of a handling and storage presentation, an Idaho® potato promotional program presentation and a 4-course Idaho® potato luncheon for 110 produce managers and supervisors from all 92 Selectos stores. One week into the promotion, Walmart El Salvador contacted the Commission asking for Idaho® potatoes and IPC programs. The planning of a seasonal launch with Burbanks is in progress for both Walmart and Selectos in the fall of 2014 in El Salvador as well as another five-week long Idaho® potato promotion with both Selectos and Walmart participation.

- A WUSATA trade mission to Taiwan accompanied by an Idaho dehy processor led to several solid leads for both retail and ingredient sales in Taiwan as well as Mainland China. This processor is currently in negotiations with a very large airline foodservice/catering division and two wholesalers interested in ingredient sales.

  The IPC also met with interested buyers and distributors for fresh table-stock potatoes and were able to share these contacts with two shipper Idaho grower/shippers that are qualified to ship fresh product to Taiwan. At present the IPC is facilitating negotiations between the buyer and two suppliers of Idaho® potatoes.

These grant funds were also used to have consistent representation at regional trade shows where the Commission was not only able to strengthen previous relationships, but gain, through each trade show, new prospects and new partners for both Idaho growers and processors.

FHA (April 8 – 11, 2014 in Singapore)

- One fresh shipper had several pre-arranged meetings with distributors and buyers in the area and walked away with 4 very promising leads
- A dehy potato processor was doing sampling at the show and walked away with +20 contacts and at least 3 serious offers of product distribution and is in negotiations with a company in Jakarta for the Indonesian distribution
- The Idaho Potato Commission has received four direct leads for fresh and 8 for dehy from the show. These leads have been qualified and sent on to Idaho growers and processors respectively.

ANTAD (March 11 – 15, 2014)

- The IPC hosted 3 Idaho companies at the show in Guadalajara. The timing of this show was critical due to the rumors of the Mexican market opening completely to U.S. potatoes. Colorado potatoes were at the show for the first time which was a sign of the competition to come
- An Idaho dehy potato processor had 5 pre-arranged meetings with current and prospective distributors and buyers and spontaneously met with several more companies very interested in their products for both retail and foodservice
- Fresh growers met with all the top-tiered grocery chains and distributors. Walmart Mexico even produced supplier papers to start the Walmart supplier process.
- When the market did open – only briefly, Idaho growers had the relationships intact and were able to start shipping potatoes over the border that first week.
- Although Mexico is closed again, the border region is still open and the IPC has promotional programs currently in place with the 2nd largest retailer in all of Mexico.

MIDA Puerto Rico (9 – 13 July, 2014)

- The funds provided this grant allowed the IPC to participate in the MIDA trade show for the 4th year in a row. The day before the show started, the Commission had a meeting with one of the largest distributors in Puerto Rico and the Caribbean Islands. This distributor had just recently started in the fresh produce business. For the new season they have already ordered 3 containers of russets and other varieties and are looking into developing their own packaging with Idaho® potatoes.
- During the show, the Commission was able to speak to 3 current buyers regarding new and extended promotions along with training for the entire cold chain. The IPC is in the planning stages of an extended promotion with over 80 stores including training and sampling – up from 15 stores last year.
- Shipments to Puerto Rico and the Caribbean have almost doubled over 2013 numbers and the Commission expects the 2014/15 season to be even stronger with IPC promotional support.

AFL Hong Kong (3 – 5 September, 2014)

- Hong Kong has been a lost market for Idaho®potatoes the last 2 or 3 years. This past year the Commission has been working diligently to rebuild relationships and re-establish Idaho®potatoes as a premium brand.
- The IPC had a booth at the Asia FruitLogistica show this year with 2 fresh shippers in attendance. Both the Greater Asia and the Southeast Asia representatives were present at the show and had scheduled 2 days of meetings for potato shippers in the booth. The shippers came away with solid leads from Hong Kong, Philippines, Malaysia, Vietnam, Singapore and Saudi Arabia.
- Logistics, pricing and promotional activities are currently being negotiated with companies from Hong Kong, the Philippines and a new buyer from Malaysia.
- A distributor from Singapore with whom the Commission has been speaking for over a year visited the IPC booth at the AFL and committed to ordering this year's Burbanks as well as other potato varieties and is speaking with the shipper and the IPC in regard to private label packaging and licensing.

Goals and Outcomes Achieved

There have been some changes to the countries IPC has been focusing on in the last year. Most of these changes have occurred because of changes in trade agreements or barriers that have been put in place making it difficult to export Idaho® potatoes into the countries the IPC first set out to focus on. (ie: Russia, South Korea and Colombia)

The following were the expected measurable outcomes stated in the grant proposal and actual markets and outcomes in the last two years in blue (as accurately as could be tracked):

	Base Year	Year 1	Year 2	Actual
Number of Fresh Exporters				
Panama	0	1	2	2
El Salvador	1	1	1	3
Guatemala	0	0	0	2
Colombia	0	1	2	0
South Korea	0	2	3	0 (closed)
Vietnam	0	1	1	2
Russia	0	1	3	2
Sales of Fresh Potatoes				Actual
Panama	0	75,000	75,000	350,000
El Salvador	25,000	25,000	75,000	175,000
Guatemala	0	0	0	50,000
Colombia	0	75,000	150,000	0
South Korea	0	150,000	225,000	0 (closed)
Vietnam	0	75,000	75,000	50,000
Russia	0	75,000	75,000	200,000 (seed)
Number of Idaho Branded Processed Items New in the Market				
Panama	0	2	4	4
Colombia	0	2	4	4
South Korea	0	3	6	0 (closed)
Vietnam	0	2	4	2
Russia	0	2	4	0 (closed)
Hong Kong	0	0	0	4

It was the goal of the IPC to have 2 companies travel with on all missions. However, timing for the shipper or budget constraints doesn't always make this possible. Often, with new markets, the companies are hesitant to spend their time or money on the unknown and rely on the IPC to explore the opportunities and establish contacts in these new markets. The IPC took part in several trade shows and missions. In most cases, it was possible to convince at least one company to accompany the Commission. Below, the outcomes of our events within the grant time period:

- An exploratory trade mission to Russia conducted by USDA. The initial visit was to assess the opportunities in Russia. On this mission, only the IPC as the industry representative was in

attendance. Since then there have been 2 growers, who have traveled to Russia and have shipped potatoes into Russia.

- A trade mission to Panama City and Bogota, Colombia. Along with the IPC, three Idaho companies participated in this double trade mission – 1 dehy company and 2 fresh shippers.
- The Governor's trade mission to Vietnam. These missions are fairly costly and Vietnam was newly opened. One fresh shipper took part in this trade mission.
- A WUSATA Southeast Asia Trade Mission to Singapore and Vietnam. The IPC travelled with one fresh shipper (not the same shipper as the Vietnam mission).
- A Central America Trade Mission to the Dominican Republic and Costa Rica. There were 2 fresh shippers and 1 dehy representative on the mission.
- The ANTAD trade show in Guadalajara – 2 fresh shippers and 1 dehy company sent representation.
- Food Hotel Asia Trade Show in Singapore was attended by one shipper and one dehy company.
- Asia Fruit Logistica Trade show – 2 fresh shippers were in attendance.

In each market visited, the Commission met many importers, buyers and distributors and received several leads thereafter:

- Russia – 12 contacts from fresh importers and buyers across the country
- Panama City – 11 contacts
- Bogota – 7 serious contacts
- Vietnam – 14 contacts
- Singapore – 19 contacts
- Costa Rica – 8 contacts – market closed for US potatoes – only some seasonal quotas
- Dominican Republic – 7 contacts – market only for seasonal – quotas are auctioned off

The Idaho® potato has been received very well in all markets the Commission has been able to support with promotional programs, and has been successful in increasing awareness and preference:

- Malaysia promotion in a large grocery chain – increased demand by 50%. The store is requesting further promotions. (The IPC promotions never include any product price reductions) – only POS materials in stores and in-store demonstrations.
- Guatemala and El Salvador – with our educational trainings for both management of the product and promotional programs the IPC has been able to convert the largest distributor for both countries to Idaho® potatoes over other options provided by competitors
- Mexico – within the border we have been able to convert from 20% of market share – away from local potatoes to 80% of the market

Beneficiaries

The trade shows, trade missions and promotional activities and training that this grant helped to fund benefited not only the Idaho shippers and processors present at these events, but the 100+ Idaho® potato growers, who fill the ever increasing orders coming from international markets.

Idaho was able to increase its international exports by 12% over the previous year. In value, that is an increase of approximately $825,000. Through trade missions, market visits and continuous follow-up

from IPC's regional representatives, Idaho dehydrated processors were able to find new retail distributors in Central America, Taiwan, and Hong Kong that increased their total sales in these targeted markets by approximately 25%.

Lessons Learned

Market prediction is not a science. Because of market access and trademark issues, South Korea was removed as a target for the 2012 grant. The goals and targets that were intended in the writing of this grant 2.5 years ago were not all met. Targeted markets closed, set up trade barriers or even banned U.S. products from entering the country. However, with flexibility the IPC was able to react quite quickly to redirect some of these funds to markets that at the time were not priority markets. Funds originally allocated to a trademark visit were used instead to fund market development activities associated with approved project goals. Central America has turned out to be a moderately strong market and growing for Idaho® potatoes. In this market, training and education has been key to their acceptance of and growing enthusiasm for the Idaho® potato and Idaho® potato products. From the Commission's experience in El Salvador, a tiered training approach has been developed that includes cold chain training, retail management, sampling of localized potato recipes and promotional program training. Going forward, this tool will be adapted and utilized in all other international markets where Idaho® potatoes are being sold.

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Additional Information

None.

Promoting Specialty Crops through Advertising, Marketing, and Education

Subrecipient
Idaho Preferred

Project Summary
In 2009 the Idaho State Department of Agriculture conducted a specialty crop industry survey to identify needs and set priorities. The top priority identified by the specialty crop industry was "Increasing Marketing and Promotion." Idaho Preferred® was well positioned to meet this need by expanding current marketing and promotion programs that had successfully increased consumer awareness of Idaho-grown products in 2010 to over 66% statewide and nearly 80% in the Treasure Valley thru effective advertising, retail and foodservice programs and educational efforts.

In order to be effective in the Idaho television market, Drake Cooper (a Boise based advertising and public relations agency) estimated that a campaign should reach approximately 85% of consumers an average of 14 times in order to reach consumer awareness of 50%. This campaign strategy had proven successful, as research showed that consumer awareness of the ads had increased from 32% in 2007 to 41% in 2008 and to 66% awareness in 2010 – a dramatic increase in just 3 years. This grant allowed for support of 3 weeks of television to supplement 6 weeks purchased through previously awarded Specialty Crop funds for 2013 and 6 weeks of television in 2014. This level of advertising was critical to maintaining awareness levels and allowed for additional small to moderate increases in consumer awareness.

"Local foods" was, and continues to be, a hot trend in both retail and foodservice channels. In fact, Produce Business Magazine named "Locally Grown" as the number one consumer trend in retail produce for 2012 (the year prior to the implementation of this grant) and the National Restaurant Association's survey of 1,600 chefs found that locally grown produce was the number two trend in restaurants for 2012 (topped only by locally sourced meat and seafood). In order to assist retailers and restaurants to source and promote local produce, this grant allowed for the development and implementation of marketing events and materials.

Previous retail campaigns had been very successful, with 39% of consumers reporting they had seen the Idaho Preferred® logo identifying local products at retail – double the number who saw it in 2008. Consumer market research conducted on behalf of the ISDA Idaho Preferred® program in 2010 found that 35% of consumers are buying more local products – up from only 19% in 2008, and 75% reported supporting local farmers and economy as their primary reason for doing so. It was critical that the specialty crop industry take advantage of this consumer trend by increasing the availability and awareness of Idaho fruits, vegetables, wines and nursery products at retail and foodservice through promotions, events and point of sale materials – continuing to increase the number of consumers who report buying more local products.

Finally, research in 2010 found that over 70% of schools reported implementing some type of Farm to School program. To increase the use of Idaho Specialty crops in school cafeterias, this project allowed for a statewide Farm to School fruit and vegetable promotion conducted in September 2013 in conjunction with Idaho Preferred® Month promotions.

Television advertising and channel promotions are a call to action to affect immediate buying behaviors. In order to affect consumers' longer term demand for local specialty crop products, other information and education programs and events must occur. This grant allowed for the continuation of a full time staff person to carry out demand building retail, foodservice, consumer education and school-related programs. These projects helped in "connecting growers to buyers" and "conducting consumer education" programs – identified as the third and seventh highest priorities in the Specialty Crop Industry Survey.

This grant funded only partial salary and fringe for two staff. When events included non-specialty crops, staff time was pro-rated based on percent of products or participants that were specialty crop. Matching state funding and Idaho Preferred® participant fees supported non-specialty crop salary and fringe as well as many of the actual program costs. This grant did not duplicate efforts of previous SCBG funds, but did extend and build upon previous grant-funded projects.

Project Approach

The purpose of this project was to increase consumer awareness and demand for Idaho specialty crop fruits, vegetables, wine, herbs and nursery products through statewide advertising, retail and foodservice promotions and Farm to School programs.

Goals Achieved

Five weeks of television advertising was placed Aug-September 2013. The ads ran in all dayparts in the Boise, Twin Falls, Pocatello, Idaho Falls and Lewiston markets. The cost of these 5 weeks was split between this and previous grants. The 30 second ads were produced with previous Specialty Crop funds and include images of sweet corn, green beans, dry beans, cherries, potatoes, apples, pears, onions and summer squash. To maximize impact of the media buy, all funds were put toward television ads and radio was not a part of the media plan for this period. Per the work plan, specialty crop television ads were again placed in Boise, Idaho Falls and Twin Falls markets during September 2014. The campaign included 5 weeks of specialty crop television ads to allow funding for on-line advertising options. The television campaign reached 91% of the target audience an average of 13 times.
Fall 2014 on-line ads included Facebook and Google Adwords. Grapes, pluots, potatoes and poinsettias were featured in these ads. The 2014 on-line campaign resulted in 21,605 website visits, 2 million impressions, 15,409 clicks and a click through rate (CTR) of .8% (industry average CTR rate is 0.1 - 1%)

Nursery programs included both retail promotions and on-line advertising. Nursery banners for identification of Idaho plant materials at retail were produced and distributed in May 2013. The banners included images of trees, flowers and vegetable plants and were distributed to retailers including Albertsons, Zamzows and Paul's Markets. In May 2014 on-line ads were introduced to the nursery campaign. Facebook ads featuring trees, flowers and vegetable plants ran 2 weeks April 28-May 11 and

delivered a total of 122,863 impressions and 1444 click throughs to the Idaho Preferred website nursery page. The second component of the 2014 specialty crop nursery campaign was homepage slider ads on KTVB.Com, the Boise market's top-rated television news website, and on Yahoo.com. The KTVB.com ads appeared on three days, April 29, May 5 and June 13. Home page slider content included flower bowls, vegetable starts and trees. On these days, ads were exclusive and in total delivered 417,024 impressions or an average of 139,008 per day and 265 click throughs. Yahoo.com ads delivered a total of 374,657 impressions but only generated 18 click throughs and as a result Yahoo.com were be deleted from future campaign plans. The final component of the nursery on-line campaign was Google Adwords focusing on nursery and Mother's Day promotion. Google Adwords ran two weeks April 28-May 11, 2014 and delivered a total of 39,337 impressions and 280 click throughs.

Incredible Edible Idaho posters focusing on Idaho berries, cherries, and apricots were produced and distributed to 750 school cafeterias and teachers in April, May and June 2013. Plum, tomato and leafy greens posters were distributed in February, March and April 2014. Pears, pea/lentil, melon and green bean posters were printed and distributed in fall 2014. Each poster includes photos of the product as it grows (in field, on tree, etc), the harvested fruit/vegetable, nutrition facts, Idaho production facts, where it fits on the My Plate graphic, and where in Idaho it grows. Posters were distributed to all school cafeterias by the Idaho State Department of Education Child Nutrition Program. ISDA/Idaho Preferred distributed to teachers who requested the posters through Idaho Agriculture in the Classroom Teacher Training Workshops or by individual request. The poster project has now been completed. All posters have been printed and packaged in full sets of 25 different product posters and will continue to be offered to teachers and school cafeterias via Ag in the Classroom and Farm to School programs.

In cooperation with Idaho State Department of Education a Farm to School pilot project involving 5 school districts was conducted in fall 2013. The five school districts represented 38 schools and over 36,000 students. During the pilot program, September 2013, these schools purchased over 7,260 pounds of Idaho specialty crops including beans, broccoli, cantaloupe, cucumbers, grapes, honeydew, nectarines, peaches, pears, peppers, pluots, potatoes, sweet corn, tomatoes, and watermelon. Posters that allow schools to promote local foods on the daily menu were produced and distributed to schools requesting them.

In addition to media, the 2014 fall campaign to promote specialty crops in Idaho included extensive retail promotions with local and national grocery chains. The grant funded signs that identified specific Idaho wines sold at retail in 21 Walmart stores in Idaho. In addition, signs were created that identified specific growers of specialty crops that were sold in Walmart stores including potatoes, apples, peaches, pears, pumpkins, tomatoes, honey, salsa and sweet corn. In Paul's Markets, a local 7 store chain, in-store signage and sampling of local fruits including plums, pears, pluots, nectarines and peaches were funded to support August newspaper ads featuring these items. Similar sampling events were conducted in 13 Albertsons stores in September. These strategies were implemented at retailers' request instead of conducting a "Ticket to Healthy Snacking" event as was detailed in the original grant plan.

Additional work on this grant included completion of two Chef tours. The first, conducted in July 2014 was attended by 48 foodservice industry professionals and included stops at a tomato farm, winery, orchard, hop farm and vegetable farm. Evaluations were very positive with overall rating of 4.83 out of 5 and 100% reporting they would participate in another similar tour. 21 of 34 respondents reported that they would buy more local produce and wine as a result of this tour. In October, a second tour was hosted in cooperation with a local brewery that took 14 foodservice and industry professionals on a tour of a hop farm and harvesting facility. No funds from this grant were expended on these tours except for staff time. As a follow-up to this tour, a sales promotion program was implemented with Sysco of Idaho that resulted in an increase in sales of 439 cases of specialty crops including potatoes and honey.

Consumer market research to evaluate effectiveness of the Idaho Preferred Specialty Crop promotion campaign and track reported local food buying behaviors was completed in November 2012 and again in 2014. The University of Idaho Social Sciences Center conducted this research. Funding for this research was split between this and a subsequent specialty crop grant and in addition, a partner was secured to share in the study which will result in reduced cost for this component of the grant. Results compared to target are:

Measure	2010 Actual	2012 Target	2012 Actual	2014 Target	2014 Actual
Awareness	66%	70%	50%	70%	52%**
Buying more local product	35%	38%	27%	43%	30%
Seeing local message at retail	39%	44%	40%	50%	37%
Buying more fruits/vegetables	83%	83%	79%	83%	94%
Buying more nursery	11%	16%	4%	21%	12%

When the grant was written in 2010, projecting four years in advance was difficult. Research was conducted first in 2012 as seen in the table above. Based on data from 2012 it became obvious that 2014 targets would not be met. These targets were adjusted in subsequent grants that used this evaluation data.

**State average awareness was 52% but the target awareness goal of 70% was nearly met in southcentral Idaho with 66% and in southwestern Idaho at 63%. Awareness of only 29% in north Idaho negatively affected statewide average. Awareness in north Idaho is very low due to the fact that the

area is served by the Spokane television market. We do not place the specialty crop ads in the Spokane market due to the cost in relation to our budget.

The research found that more consumers are buying more local products, but fell short of the targeted 43%. However, the number of people who report buying more local fruits and vegetables far surpassed the goal of 83% to reach 94%! The target of 21% of consumers reporting buying more local nursery products was not met. And despite increased retail promotions, fewer people actually reported seeing the local message at grocery stores.

Finally, this grant provided funding for staff to work on Specialty Crop related projects. To date, staff has accomplished the following:

Three consumer events will be conducted to increase consumer awareness and provide opportunities to purchase specialty crop items directly from growers and processors.(Summer-Fall 2013-14)

- Sippin' in The City (Boise, November 2013 and 2014) is an annual fall food and wine event where several Idaho wineries are represented. Idaho Preferred sampled and promoted Idaho apples and pumpkins at these events to over 250 consumers each year.
- Taste 208 (Boise, April 2014) TASTE208 is a tasting event focused on the spring release of the best local beer, wine, spirits, and food in Idaho. Idaho Preferred sampled and promoted Idaho asparagus at this event to over 600 consumers.
- Locavores Night Out (Driggs, April 2014) is an annual event that promotes locally grown food and Idaho producers. Idaho Preferred promoted a variety of locally grown produce at this event to over 400 consumers from Eastern Idaho.
- Savor Idaho (Boise, June 2014) - Idaho's premier wine and food event hosted by the Idaho Wine Commission. Wine and food related exhibitors are allowed to educate and sample Idaho grown foods and wines. Idaho Preferred created a dish that promoted Idaho grown tomatoes, onions, and herbs to over 1000 consumers.

The number of schools serving Idaho Specialty crop products in their cafeterias will increase by 10% in 2012 and 2014.

As detailed above, Farm to School programs in 2013-2014 focused on production and distribution of materials developed to increase students' awareness of specialty crops and the health benefits of consuming fruits and vegetables. The materials were sent to school teachers for use in the classroom as well as to foodservice staff to display in the cafeteria. Data was not collected on number of schools serving local products. However, a USDA Farm to School Conference and Events grant was received in late 2014 and 4 workshops were held in early 2015. Of the 68 who answered the question, "As a result of this workshop do you plan to serve more local products," 66 or 97% answered yes.

At least 10 seasonal blogs and Facebook postings relative to Idaho specialty crops will occur in 2013 and 2014.

Weekly Facebook posts and *monthly* blog posts have highlighted specialty crop items including nursery products, fruits, vegetables, wine, hops, pumpkins, squashes and more.

Ten new specialty crop producers will be recruited to take part in demand-building programs.

1. Sunnyside Farms
2. Crawford Farms
3. Spyglass Gardens
4. Terra Nativa Vineyard
5. 13 Foods
6. Northview Orchard
7. Potandon Produce
8. Nielsen Bros.
9. Olson's Greenhouse
10. Moss Greenhouse
11. Giant Produce
12. Fresh Cut Fries

Three new retailers will begin identifying local specialty crop items in their stores.

1. Ridley's Family Market
2. Direct Local Foods
3. Winco (wine)

Five new restaurants will begin identifying local specialty crop items on their menus.

1. Louie's
2. Flatbread Pizza
3. Brown Shugga Soul Shak
4. Wahooz Family Fun Zone
5. McCall Brewing
6. Zee's Rooftop Café
7. On the Fly Deli

Beneficiaries

Data from the 2011 Idaho Agriculture Statistics bulletin estimated the value of specialty crops grown in Idaho at over 1 billion dollars. This estimate included cash receipts from potatoes, fruits, vegetables, mint, and nursery crops. All producers engaged in the production of specialty crops in Idaho could potentially benefit from effective television advertising, channel marketing and Farm to School programs that increase consumers' awareness and intent to purchase Idaho fruits, vegetables, and

nursery products. Unfortunately, as is the case with most perishable fresh products, it is very difficult to measure the effect of advertising on sales as all products will be sold at some price, and price becomes more a reflection of supply than of demand. Additionally, retailers do not distinguish between local and non-local products on their UPC codes – ie: fresh peaches are fresh peaches whether they are local or from out state or even out of country. Therefore, obtaining sales data for local products from retailers is not plausible. However, *awareness* and *intent or reported purchase* of local products can be measured as reported earlier in this document.

Idaho Preferred® currently includes 290 members, 96(or 33%) of which produce and/or process specialty crops. All of these current members, as well as those who may have been members during the time period covered by this grant, may have directly benefited from the advertising campaign and promotions linking growers and processors to retail and foodservice buyers and from consumer education programs designed to build long term demand and "brand loyalty" for local specialty crop products. In addition, due to the fact that all promotion encourages consumers to buy local specialty crops, event those producers who do not participate in the Idaho Preferred program may benefit from these promotion programs.

Lessons Learned

Projections based on 2010 research and trying to project 4 years out proved to be somewhat unrealistic leading to what appears to be poor performance of the project. However, when looking at 2014 results as compared to 2012 actuals, positive trends can be seen in most measureables. And, as noted above, it is very difficult to measure the effect of advertising on sales as retailers do not distinguish between local and non-local products on their UPC codes and therefore cannot segregate sales of based on whether they are local or from out state or even out of country. Therefore, using sales data to evaluate marketing programs for local products at retail is not possible.

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Additional Information

Television commercials and photos of retail promotions, chef tours, etc can be seen at http://idahopreferred.com/about-us/

From Field to Table – A Video to Build Awareness and Increase Education About Idaho-Eastern Oregon Onions on a Global Level Education

Subrecipient
Idaho-Eastern Oregon Onion Promotion Committee

Project Summary
Onions grown in the Idaho-Eastern Oregon onion region are governed by Federal Marketing Order #958 (M.O.); the M.O. maintains quality and size standards that exceed USDA standards. The IEOOC was formed to promote this high-quality onion, and the onions are distributed both domestically and internationally. The purpose of this video project was to design a cost effective and desirable way to distribute Idaho-Eastern Oregon Onion educational information to onion buyers and consumers. Now more than ever, onion buyers and consumers want to increase their knowledge and education about the food they purchase, particularly produce. From growing practices to proper preparation and cooking techniques, food education is in high demand. The video allowed the IEOOC to demonstrate proper handling techniques for onions as well as give preparation tips and show different applications for the use of Idaho-Eastern Oregon Onions. The grant also allowed the IEOOC to distribute the video on an international level through Facebook, the Committee Website and at international and domestic Trade Conventions.

Project Approach
The video was completed in the fall of 2012, and was immediately placed on the IEOOC website to start distribution. Marketing Director Sherise Jones, worked with the production company for the creation of the video. Executive Director Candi Fitch worked with the same company to have the video translated into Spanish and French Canadian. DVDs were created with the translated videos for distribution at the conventions and trade shows. The video was played in the booth at the international shows and domestic shows during the time period of the grant.

The Committee had intended to participate in the Foodex Convention in March 2013. However, after careful consideration the IEOOC felt that the funds would be of better use to attend conventions in the markets the Committee had deemed their countries of focus. The video has been shown a couple of times at the Canadian Produce Marketing Association Convention (CPMA). The CPMA Convention had an average attendance of about 4,000 people. While at the show we answered questions about the Idaho-E. Oregon Onion growing region and provided information to get in touch with the area shippers. We also made attendees aware of the Committee's web site. The video was played the entire length of the conventions the Committee attended. With access to the web site people did not request the video. The same activities are provided at all of the trade shows the Committee attends. The Americas Food and Beverage Show had an average attendance of about 10,000. CPMA is a three-day trade show, and the Americas Food and Beverage and the Produce Marketing Association Convention are both two day shows. The Produce Marketing Association Convention has an attendance of about 20,000 people. The DVD was also taken for distribution on a Costa Rica/Dominican Republic trade mission in which the Committee participated. The video was shown at an evening reception during the trade show with an attendance of about 30 people. IEOOC was able with grant funding to have promotional materials

translated into Brazilin Portuguese, Spanish, and French Canadian. The grant funding also allowed for the printing of promotional information. The Brazilian Portuguese pieces were distributed on a Brazilian Trade Mission that IEOOC participated in November 2014.

Goals and Outcomes Achieved

The purpose and goal of the grant was to increase the knowledge and awareness of Idaho-Eastern Oregon Onions and in doing so build a higher demand for, and increased sales of, Idaho-Eastern Oregon onions domestically and internationally. We had projected we would increase Facebook "Likes", visits to the IEOOC's two web sites, and requests for informational and educational materials. For the grant period we had estimated an increase in views of the IEOOC website of about 25% each year, but we had a total increase of 38% for the grant period. During the grant time period our Facebook "Likes" increased by 70%

Since distributing the video on Facebook and during the time period of the grant, the increased "Likes" that came from other countries: Mexico-9, United Kingdom-7, Canada-6, Australia-4, Japan-2, Brazil-2, Uganda-2, Philippines-2, Chile-2, Italy-2, India-2, Spain-1, Malaysia-1, El Salvador-1, Kenya-1, Belgium-1, Vietnam-1, Germany-1, Egypt-1, Pakistan-1, Taiwan-1, Netherlands-1, Ecuador-1.

This is encouraging as many of the "Likes" come from the countries the IEOOC has used as their focus. These numbers are encouraging, to show that these are useful venues to distribute the information about IEOOC, and to continue to increase knowledge and awareness as outlined in the grants goal. We will continue to build on these numbers.

Specifically, Marketing Director Sherise Jones has started monitoring the number of views the video received on the IEOOC's websites and social media, and all email information requests on a weekly basis. Also, Executive Director Candi Fitch and IEOOC office staff are starting to monitor requests for CD mailings and other educational information requests received as a result of viewing the videos. The office staff has followed up with 1/3 of the people who have requested videos to survey them and see if the videos made an impact on their use of onions and/or their buying decisions either on a retail, foodservice, or consumer level.

The purpose and goal of the grant was to increase the knowledge and awareness of Idaho-Eastern Oregon Onions and in doing so build a higher demand for, and increased sales of, Idaho-Eastern Oregon onions domestically and internationally. IEOOC had projected an increase in Facebook "Likes", visits to the IEOOC's two web sites, and requests for informational and educational materials. For the grant period IEOOC had estimated an increase in views of the website of about 25% each year, but had a total increase of 38% for the grant period. During the grant time period Facebook "Likes" increased by 70%

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Beneficiaries

There are about 300 onion growers, and about 36 onion packinghouses in the Idaho and Eastern Oregon Onion region, and all of these companies benefit from this grant. The Idaho-E. Oregon Onion growing region is the one of the largest in the United States, and therefore it is very important that the regions presence continues to grow and continue to increase awareness of the onions in this area. There are approximately 20,000 acres of onions planted annually Idaho and Eastern Oregon.

Lesson Learned

With the increase of Social Media and the website, there are fewer requests for printed material from the website. With the Social Media aspect you are able to spread the information a lot further. Distribution of printed materials and DVDs are still needed, and they are distributed through trade shows and by company requests. The grant funding allowed the IEOOC to have information translated, produce and distribute a video, and produce printed materials in three languages.

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Development of a Crop Monitoring and Assessment Platform (C-MAP) for Specialty Crops in Idaho

Subrecipient
Northwest Nazarene University

Project Summary
A cost effective remote sensing technology named Crop Monitoring and Assessment Platform (C-MAP) was developed to help the specialty crop growers in Idaho monitor plant status and condition. The C-MAP is an unmanned aerial vehicle with a multispectral imaging sensor that can measure the plant's spectral reflectance in both visible and near infrared bands. The Normalized Difference Vegetation Index (NDVI) of the crops were calculated from the images and used as an index to evaluate plants' anomalies which could be attributed to water stress and nitrogen deficiency. By using this technology, farmers will be able to manage their farm more efficiently by optimally controlling crop inputs such as irrigation, fertilizer, and chemical application. This would lead to lower cost of production, improve yield and quality, and decrease environmental impact.

Project Approach
The C-MAP is composed of an unmanned aerial vehicle (UAV) and a multispectral sensor, which is a color and near-infrared camera. An experimental apple orchard in the Parma Research and Extension Center of the University of Idaho was used as a test field for this study. The experimental orchard has a controlled input of both irrigation and nitrogen. The UAV was flown over this orchard and multispectral images (Figure 1) were acquired during the summer season of 2013 and 2014. Image processing algorithms were developed to process and analyze the images. Specifically, the multispectral images were analyzed using the Normalized Difference Vegetation Index (NDVI).

Goals and Outcomes Achieved
The following are the goals and outcomes achieved:

1. Goal 1: To acquire remote sensing data (multispectral images) of apple groves and grapevines.

   Outcome 1: We were able to develop a cost-effective crop monitoring and assessment platform. The components of C-MAP can be easily obtained from off-the-shelf kits, cameras, and electronic parts. We are currently developing a guideline that an Idaho specialty crop farmer can use.

2. Goal 2/3: To use image processing techniques to process and analyze the multispectral data and to correlate the multispectral data with the water stress, nitrogen content, and disease condition of the field.

   Outcome 2: We developed an image processing algorithm that can process and analyze the acquired images. The algorithm can process the multispectral images and calculate the NDVI, and then display the NDVI false color image which shows the NDVI values for the crop across the field. The NDVI images showed a good correlation between the water input data of the

experimental orchard. Based on literature survey, there has been no study yet conducted on the relationship between NDVI images and water stress on apple orchards (Figure 2). Currently, the algorithm is implemented using Matlab, which is a commercial software. We are looking for options to find open source alternatives.

The results of this project has been presented in both regional and international conferences in agriculture.

3. Goal 4: To acquire remote sensing datae of grapevines infected with powdery mildew and healthy grapevines and develop an image processing algorithm to characterize powdery mildew.

   Outcome 4: We collected multispectral images of two rows of grapevines for two consecutive years; one was applied with a chemical that protects against powdery mildew and the other was not. However, because of the hot condition during the years that data were collected, there was no powdery mildew infection in the controlled grapevines. We were able to develop the NDVI images of the grapevines, however we were not able to correlate it with powdery mildew. This limited the analysis of diseases using NDVI. We will try to make local contacts with local growers and see if we will have a chance to see powdery mildew this year.

4. Goal 5: To submit research results to ISDA and present results to local growers during education workshop; to develop a website that will present the research progress; to publish the research results in agriculture related conferences and journals.

   Outcome 5: We have submitted quarterly and semi-annual reports to ISDA. In addition the results of the project were presented to local growers during the University of Idaho Parma Fruit Field Day 2013 and 2014, and a field demonstration was also shown. Over 100 farmers attended the field day and have expressed interest in the project. However, we did not conduct a written survey to investigate the farmer's interest on the project, due to lack of time and logistics during the field day. We only asked the farmers when they visited our booth. Two of the biggest fruit companies in Idaho, Symms Farms and Henggeler, have expressed interest in using the technology in their production. In addition the project was also featured in the July 2014 edition of the Idaho Statesman Business Insider (http://issuu.com/idahostatesman/docs/0716_businessinsider_48p)

   We have also developed a website, http://www.nnu.edu/blogs/robotics-vision/ that shows the results of the project. The website was tracked using Google Analytics and it has 537 page views as of July 30, 2015. Website comments have been collected and answered (Additional Information).

   We also have presented and published in conference proceedings the results of the project (9 papers were presented – see Additional Information). The results were presented in regional conference such as the Idaho Academy of Science conference and Murdock Trust Undergraduate Research Conference, where about 500 attendees were present. We also presented in the American Society of Agricultural and Biological Engineers 2014 international conference, where about a 1000 participants (faculty, researchers, students, growers, and

manufacturers) attended. Our paper has been accepted for the 2015 ASABE international conference in New Orleans, LA.

Beneficiaries

The following are the beneficiaries of the project:

1) Specialty crop farmers (over 100 farmers)

   Majority of Idaho's specialty crop farmers are still using the conventional farming practice of uniform field treatment. Precision farming is hardly ever used for specialty crops in Idaho. Few farmers are using sensors such as soil moisture sensor in very limited quantities. This project will provide a cost-effective whole field monitoring to farmers and advance the knowledge and application of Precision Agriculture. During the 2014 Fruit Field day in Parma, over a 100 fruit farmers attended the field day and have expressed their interest and desire to have a monitoring platform. Two of the largest fruit producers in Idaho, Symms Farms and Henggeler Packing companies, have expressed interest in using this technology in their farms.

2) Environment and economic impact (about 100 farmers)

   By monitoring the water stress level of the crops, the farmer can control irrigation and lessen the environmental impact and conserve our natural resources. In addition, by conserving water, the farmer has the potential of reducing the production cost while maintaining high quality fruits.

3) Local community (about 200 high school students/100 college students)

   As part of NNU's concurrent engineering program in the local high schools, NNU conducts seminar to local schools (middle school and high school) about the project. About 200 high school students and over 100 college students have attended the seminars conducted about this project. This will provide advanced scientific knowledge to students and help in the STEM (Science, Technology, Engineering, and Mathematics) program of Idaho.

Lessons Learned

1) There were a few challenges that we have faced in the operation of the remote controlled UAV. One of the challenges is the operation of automatic waypoint navigation. To solve this issue, we were able to find flight controllers that have easy to use navigation system. By developing a guideline for operation, this will help farmers in adopting the technology. The other challenge is using the GPS and monitoring the environmental condition. Proper monitoring of environmental factors such as solar storm will minimize flight operation difficulties.
2) The C-MAP was also used to acquire images over grape vineyards in the Parma Research Center and in Bitner vineyards to monitor diseases such as powdery mildew. However, during the two year period, there was no powdery mildew observed in Parma and there was very minimal infected grapes in Bitner orchards that limited the analysis of diseases using NDVI. We will try to make local contacts with local growers and see if we will have a chance to see powdery mildew this year.

Contact Person

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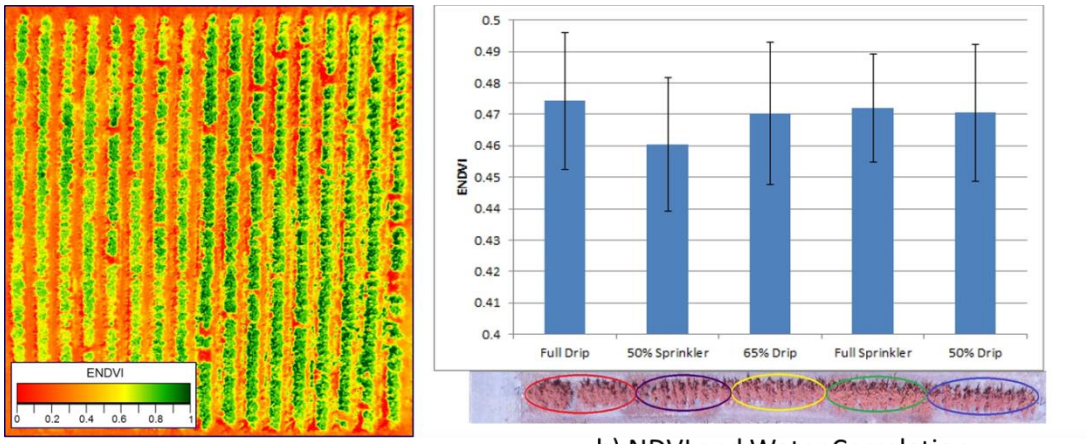
Additional Information

1) For further information about the research project, visit the research website: http://www.nnu.edu/blogs/robotics-vision/
2) Research Publications:
    a. Horton M, Salvador P, Bulanon DM. 2012. Machine Vision System for Agricultural Applications, 21st Regional Conference on Undergraduate Research of the Murdock College Science Research Program, October 26-27, 2012, Whitman College, Walla Walla, WA
    b. Salvador, P., Horton, M., and Bulanon, D. 2013. Machine Vision System for Agricultural Applications. Poster Presentation at the 2013 IEEE Workshop on Microelectronics and Electron Devices in Boise, ID
    c. Horton M, Salvador P, Bulanon DM. 2013. Estimating the Volumes of Trees Using Machine Vision Systems, Journal of the Idaho Academy of Science, 49(1): 3
    d. Bulanon DM, Parke S. 2013. Crop Monitoring System: A Case of Teaching Machine Vision through Undergraduate Research, Annual International Conference of the American Society of Engineering Education, June 20, 2013, Atlanta, GA (*2013 Best Paper Award- Computing and Information Technology Division*)
    e. Horton, M, Salvador P, Beech R, Lambert K, Bulanon DM. 2013. Monitoring of apple orchard using multispectral imaging, 22nd Regional Conference on Undergraduate Research of the Murdock College Science Research Program, November 8-9, 2013, Lewis & Clark College, Portland, OR
    f. Horton M, Salvador P, Bulanon DM. 2013. Farmer in the Sky: Orchard monitoring using aerial imaging system, 22nd Regional Conference on Undergraduate Research of the Murdock College Science Research Program, November 8-9, 2013, Lewis & Clark College, Portland, OR
    g. Bulanon, D.M., Horton, M., Salvador, P., Fallahi, E. 2014. Apple Orchard Monitoring Using Multispectral Aerial Imaging. 2014 Annual International Meeting of American Society of Agricultural and Biological Engineers in Montreal, Canada
    h. Leber, D., Lonai, J., Salvador, P., Skovgard, H., Bulanon, DM. 2014. Targeted Crop Health Analysis via UAV Photography. 2014 Idaho Conference on Undergraduate Research, July 30-31, 2014, Boise State University
    i. Bulanon, D.M., Lonai, J., Skovgard, H., Fallahi, E. 2015. Automatic Detection of Individual Trees in an Apple Orchard Using Modified Watershed Algorithm. 2014 Annual International Meeting of American Society of Agricultural and Biological Engineers in New Orleans, LA.

3) Example Figures of Results:

a) Near-Infrared Image a) Color Image

Figure 1 Color and NIR images of an apple orchard



a) NDVI Image b) NDVI and Water Correlation

Figure 2 NDVI orchard map and water input correlation

4) Common Questions/Comments and Answers

a. **Is this team affiliated with another organization?**

We are funded by Idaho Space Grant Consortium which is a branch of NASA as well as the Idaho Department of Agriculture and the Watson Fellowship, they actually make it possible for us to do our research!

b. **The blog talks about what you are currently working on, but what other projects have you worked on?**

The current team just started our research, other than Professor Bulanon we are all new. The team is currently trying to perfect the use of the unmanned aerial vehicle, so that in the future it would be simple enough for a farmer to fly himself. We are also trying to complete a computer program that collects data automatically from the photos that are taken.

c. **What is the purpose of your research? How would developing this project affect future research/the community/etc.?**

The purpose of our research is to develop engineering technologies that will improve crop production efficiency to sustain agricultural production not only in Idaho but the whole world.

d. **What is the significance of the events that are coming up?**

Professor Bulanon is attending the conference in Canada for the America Society of Agricultural and Biological Engineers which helps get our research to a larger audience. This paper also shows other researcher what kind of work we are doing and what we have accomplished thus far.

The Pomology and Viticulture Program Annual Fruit Field Day is open to the public and is an information presentation to discuss and answer questions on various cultural practices of fruit crops. The is open to the public so anyone from commercial growers, small farm growers, students, home gardeners and professionals will be in attendance.

In October we will be visiting the NASA Jet Propulsion Laboratory in California for collaboration with NASA. As part of grant we are working with the Mobility and Robotic System section of JPL headed by Dr. Richard Volpe to interact with the other researchers.

e. **What is the history of this group? How long has it been around, why was it started, etc?**

Professor Bulanon came to NNU in August of 2011 and the research group started the summer of 2012. It was started because Professor Bulanon has a background in agricultural engineering and an interest in starting new research in Nampa. Professor Bulanon starting with a small team trying to recognize tree in the orchard using a color camera.

Monitoring Potato Psyllids and Zebra Chip in Idaho and Examining Effects of Disease on Tubers During Storage

Subrecipient
University of Idaho

Project Summary
Zebra chip (ZC) is an emerging disease of potatoes that causes millions of dollars in losses annually to growers in the southwestern United States. ZC was first identified in Idaho potatoes during late 2011. During the 2012 season in Idaho, the estimated increase in production costs associated with additional insecticide sprays for potato psyllids was $125-175, $85-125, and $35-85 per acre for southwestern, south-central, and eastern Idaho, respectively (P. Patterson, personal communication). The causative agent of ZC is a bacterium (*Candidatus* Liberibacter solanacearum [Lso]) transmitted by the potato psyllid (*Bactericera cockerelli*).

It is unclear whether ZC will remain an occasional, relatively minor but important threat to Idaho potato production, or whether the threat will expand in the coming years. However, most growers are taking a risk-averse approach that includes a robust spray program targeting potato psyllids. In order to develop more robust approaches to managing potato psyllids and ZC, it was necessary to clarify the extent and severity of the threat of this disease to the Idaho potato industry. We pursued this aim by monitoring potato psyllids, Lso, and ZC in commercial Idaho potato production over the 2013-2014 field seasons and by examining the effects of this disease on tubers during storage. This project allowed us to respond quickly to the immediate industry needs to deal with this new and emerging pest problem, while providing information that will allow us to develop more long-term management approaches using enhanced knowledge of the pest. Our monitoring program has been effective at identifying the level of risk of ZC to Idaho potato growers and at providing growers with information needed to make timely management decisions.

Project Approach
Psyllid monitoring program

The overall potato psyllid monitoring program was overseen by Wenninger, with Thornton and Nolte managing the weekly trapping programs in southwestern and eastern Idaho, respectively. All psyllids and plant samples were analyzed for the presence of Lso by Karasev. Olsen oversaw all storage components of the project.

Potato psyllids and Lso were monitored in a total of 108 (during 2013) and 88 (during 2014) commercial potato fields across Idaho. Each year, thirteen of these fields were monitored using an “intense” program, and the remaining fields were monitored using a “light” program. The intense sampling program was comprised of 10 yellow sticky traps per field, one 5-minute vacuum sample per field, and 100 leaf samples per field, with samples taken at weekly intervals. The light program featured 4 yellow sticky traps per field, with samples also taken at weekly intervals. Sampling began as early as mid-May (depending on location) and continued until vine kill. We read approximately 9,804 and 8,560 sticky cards, respectively, during each of the two years of the project.

Updates on the monitoring program were posted at least weekly through various means (e.g., PNW Pest Alert, Potato Progress newsletter, Kimberly R&E Center website, and Miller Research newsletter) in order to help growers and crop consultants use the information to make psyllid management decisions. The PNW Pest Alert has more than 500 subscribers to potato-related alerts, the Potato Progress newsletter has a distribution list of about 1,000 people, and the Miller Research newsletter has a distribution list of over 200 people. Unfortunately, our Kimberly R&E Center website does not allow us to view metrics on visits to our psyllid alert page.

Psyllid numbers were relatively low during 2014 compared to 2013, which were low compared to the previous year (Fig. 1; 2012 data were collected before the current grant, but are included in this report to provide a more complete comparison among years). Numbers were lower despite a relatively early detection of psyllids during 2014. Similar to the previous two years, psyllid numbers increased gradually over the season, which a sharp increase just at the end of the season and a sharp decline as most fields were being harvested (Figs. 1-2). Also similar to last year, psyllids were more abundant in the Treasure Valley (southwestern Idaho) than in the Magic Valley (southcentral Idaho), and very few psyllids were observed in the Upper Snake region (Figs. 1-2).

Far fewer psyllids were collected in vacuum samples compared to sticky trap samples. In addition, scarcely any psyllid nymphs or eggs were found in leaf samples during both 2013 and 2014 (data not shown).

In addition to seeing a decline in the number of psyllids compared to 2012, few psyllids were found that tested positive for Lso during 2013-2014. Indeed, only four positive psyllids were found in our monitoring network during 2014 (Table 1). The incidence of Lso during 2013 and 2014 was more in line with the rates typically seen in other parts of the country, however. The incidence of Lso in psyllids during 2012 was about 8.6 times higher than the incidence observed during the following two years. The decline in psyllid numbers observed during the last two years is even more compelling when considering that the sampling effort was much higher during these years compared to 2012 (Table 1). The number of psyllids collected per card has declined approximately five-fold each year (Table 1).

Levels of ZC in Idaho potato fields has been nil for the last two years. Because of the nearly complete lack of ZC in commercial potato production in Idaho during 2013-2014, we were unable to relate potato psyllid and ZC incidence to insecticide programs and other agronomic conditions associated with each field sampled. However, the incidence of ZC during each of the past three years has been more or less consistent with the psyllid numbers and Lso incidence detected in our monitoring program. This suggests that our monitoring program is effective at identifying the level of risk of ZC to Idaho potato growers.

Storage studies

We examined the effects of storage temperature and duration, along with the impact of zebra chip and Lso infection, on processing quality and sprouting behavior. We developed a systemic approach based upon natural zebra chip infection occurring in commercial and research plots (2012) and inoculated research plots for 2013 and 2014. Studies were designed to address the correlation between foliar symptoms and zebra chip development in storage.

Field and symptom development

Tuber processing quality was assessed on individual plants in commercial fields. Not all tubers under an infected plant resulted in zebra chip (Fig. 3). Assessing risk of tuber zebra chip infection from foliar symptoms may be misleading. To assess whether zebra chip was more predominant on the edges of commercial fields due to psyllid migration patterns into the field, samples were collected from various areas in the field. Initial results indicate the presence of Lso and zebra chip throughout the field. Some tubers at harvest show a mild symptom that is difficult to differentiate among zebra chip, net necrosis, and stem end. By rating tuber symptoms for none, mild, or severe, all severe symptoms tubers were positive for Lso and 50% of the mild rated tubers were positive for Lso. This made it difficult to identify Lso infected tubers displaying mild or no symptoms. Inexpensive and rapid means to qualify the presence or absence of Lso are needed.

Processing quality in storage

Approximately 3 tons of 'Russet Burbank' tubers were harvested from a psyllid sentinel plot to monitor ZC development in storage. A baseline ZC incidence rating was established from 200 tubers and the remaining were cured at 55°F and 95% RH for 14 days and ramped to either 42°F or 48°F. A 100-tuber sample was periodically evaluated for ZC incidence, severity, glucose, sucrose, and fry quality. Initial at-harvest sampling indicated 2% severe zebra chip. There was no significant difference in the percent of naturally infected tubers showing ZC symptoms stored seven months at 42°F (6.4%) or 48°F (4.9%), or among months sampled. Russet Burbank tubers stored at 42°F produce unacceptable fry color with or without ZC symptoms. Tubers showing no internal discoloration and stored at 48°F showed higher processing quality as determined by glucose, sucrose, and fry color. Tubers with severe ZC symptoms showed the highest sugar concentrations and darkest fry color. However, storing at the warmer temperature did not produce acceptable processing quality when severe ZC symptoms were present in the raw tuber. Unacceptable fry color cannot be ameliorated in ZC-infected tubers. Glucose levels in ZC-infected tubers were often 5 times higher than non-zebra chip infected tubers.

Diabetic test strips were evaluated to ascertain whether a tuber can be assayed quickly for ZC infection via rapid glucose measurement without slicing, frying, or testing for Lso. This method appeared to be accurate for tubers with severe ZC symptoms, but was equivalent to slicing a tuber open and visually observing symptoms.

An additional question asked was whether fry color can be used to determine the presence or absence of ZC or Lso. Our current fry color assessments indicate the inability to rely upon this method to identify Lso presence definitively. For example, in January, there were 38% false positives (i.e., fry symptoms but negative Lso) in 'Chipeta,' 6% in 'Norkotah,' and 4% in Russet Burbank. In comparison, there were 4% false negatives (i.e., no fry symptoms but positive for Lso) in Chipeta, 6% in Norkotah, and 0% in Russet Burbank.

Sprout development

About 800 pounds of tubers from a Russet Burbank field showing foliar symptoms of Lso infection were stored at the University of Idaho Kimberly Potato Storage Research Facility (KREC) to monitor ZC development over time. A baseline ZC incidence rating was established (100 tubers) and remaining

tubers (800 tubers) were cured at 55°F and 95% RH for 14 days and then ramped to a holding temperature of 48°F. Tubers were not treated with a sprout inhibitor. Tubers with and without ZC and/or irregular sprouting were evaluated for ZC symptom rating. The percent of tubers with ZC symptoms ranged from 1 to 13 depending upon the month sampled. No ZC infected tubers sprouted in this study.

Non-sprouting tubers collected from other studies and kept in warmer storage conditions, however, developed hair sprouts (very weak and spindly) and kinder tubers (Fig. 4). These tubers (n = 8) showed ZC symptoms upon slicing and were positive for Lso. All eight tubers were positive for Lso (Haplotype A) and all sprouts tested negative for Lso. Kinder tubers formed from two of the ZC tubers and were negative for Lso except one sample.

These results demonstrate the low risk of sprout development to occur in Russet Burbank tubers with obvious ZC symptoms regardless of when they are removed from storage. In addition, if sprouting or kinder tuber development occurs, the likelihood of Lso presence is very low. The sprouting reaction from Lso-infected Russet Burbank tubers indicates a very low probability in the subsequent development of a productive plant. Further, this study emphasizes the need to evaluate sprouting response to Lso in a range of cultivars and the ability for asymptomatic Lso infected tubers to sprout. Additional studies commenced the following year with Russet Burbank, Chipeta, and Russet Norkotah. Plants infected later in the growing season showed a greater risk of having Lso with no symptoms at harvest as well as a greater likelihood to produce a viable sprout. Integrating the use of sprout inhibitors should mitigate the risk of sprout development.

Goals and Outcomes Achieved

A Zebra Chip Advisory Committee was formed during 2012 and met during November or December of each of the following two years (during the current grant). Initial plans for measuring outcomes included surveying growers just at the Idaho Potato Conference; however, University of Idaho ended up performing targeted surveys of growers and industry representatives at our advisory group meetings as well as via surveys through the PNW Pest Alert system. At the Advisory Committee meeting during November 2013, 88% of respondents (n = 43) supported the continuation of our monitoring program. An even more robust level of support was recorded during the 2014 meeting: 100% of respondents (n = 46) supported continuation of our monitoring program. Following both the 2013 and 2014 field seasons, a survey was conducted on PNW Pest Alert system subscribers. Respondents who grew potatoes or were field representatives of the potato industry were asked (1) whether zebra chip was an important consideration in their operations and (2) to describe whether and how the potato psyllid alerts were useful. During 2013, 84% (n = 19) of potato industry representatives stated that zebra chip was important to their operations, and during 2014, 85% (n = 20) stated so. During both years, there was an overwhelmingly positive response from respondents stating that the alerts helped them to time insecticide applications, including waiting to apply insecticides until potato psyllids occurred in a given area. We initially targeted 30% of growers receiving psyllid alerts to use this information in their management program, however, 100% of respondents during both years used our alerts.

University of Idaho was unable to provide specific details on cost savings as a result of the more efficient and targeted sprays that were facilitated by our monitoring program. However, during 2012, the estimated increase in production costs associated with additional insecticide sprays for potato psyllids was $125-175, $85-125, and $35-85 per acre for southwestern, south-central, and eastern Idaho, respectively (P. Patterson, personal communication). Thus, the ability to eliminate one or two sprays from a growers program would represent a substantial cost savings.

University of Idaho also had planned on using hits to our U-Idaho potato website as a metric of outcomes; unfortunately, due to ongoing changes in the webhosting platform to the University's websites, we have been unable to obtain such metrics. Therefore, baseline data on website hits prior to implementation of expanded potato psyllid monitoring program, were unavailble for comparison to these with hits that occurred during the monitoring season.

Beneficiaries

Idaho potato industry as a whole, including the Idaho Potato Commission, potato processors, the insecticide industry, and–in particular, potato growers and crop consultants— benefited from the completion of this project's objectives. Knowledge of the incidence and abundance of potato psyllids and Lso allowed growers to make informed decisions on the need for and timing of insecticide applications. Responses from the survey as well as anecdotal evidence from interactions with growers and crop consultants told University of Idaho that many growers used our monitoring information to delay or forgo insecticide applications. During the 2012 season in Idaho, the estimated increase in production costs associated with additional insecticide sprays for potato psyllids was $125-175, $85-125, and $35-85 per acre for southwestern, south-central, and eastern Idaho, respectively (P. Patterson, personal communication). University of Idaho does not have figures on these costs during the 2013-2014 seasons; however, costs for many farms almost certainly were lower when growers were able to avoid calendar-based spray programs and apply insecticides only when justified by information from our monitoring program.

Lessoned Learned

Before beginning this project, the conventional wisdom had been that potato psyllids cannot overwinter in the Pacific Northwest and migrate to our area annually. Our results (coupled with overwintering observations) show that psyllid distribution and abundance patterns reflect the temperature and elevation gradient across the state. That is, psyllids are more abundant in the western, lower elevation growing area than the eastern, higher elevation growing area.

University of Idaho felt that the monitoring program had value, but is unsure as to whether our stakeholders would continue to support the program if ZC incidence in Idaho waned. The overwhelming support of the program following two years of essentially no ZC in Idaho underscores its value to the industry.

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Additional Information

Presentations

Olsen, N., J. Miller, E. Wenninger, M. Thornton, and A. Rashed. Update and prioritization of zebra chip research and extension efforts. Idaho Zebra Chip Advisory Committee, Rupert, ID. December 16, 2014**.** (25 attendees)

Wenninger, E.J., N. Olsen, M. Thornton, P. Nolte, J. Miller, J. Dahan, and A. Karasev. "Three years of monitoring potato psyllids, *Candidatus* Liberibacter solanacearum, and zebra chip in Idaho." SCRI Zebra Chip Annual Reporting Session, Portland, OR, 2014. (75 attendees)

Rashed, A., L. Paetzold, L. Woodell, N. Olsen, F. Workneh, M. Rashidi, E. Wenninegr, and C.M. Rush. "*Candidatus* Liberibacter solanacearum development in Russet Norkotah under commercial storage conditions." SCRI Zebra Chip Annual Reporting Session, Portland, OR, 2014.

Wenninger, E.J. "Potato psyllid and zebra chip insecticide trials." Idaho Association of Plant Protection meeting, Jerome, ID, 2014. (75 attendees)

Olsen, N. 2014. University of Idaho Project Update. IACI Executive Committee Meeting, 86th Annual Idaho Grower Shippers Association Convention, Sun Valley, ID. August 27, 2014. (40 attendees)

Dahan, J., B. Thompson, E.J. Wenninger, N. Olsen, and A.V. Karasev. **"**Analysis of the prevalence and haplotypes of *Liberibacter solanacearum*, the causal agent of Zebra Chip disease, in South-central Idaho during the 2012 and 2013 potato growing seasons." Potato Association of America meeting, Spokane, WA, 2014**.** (50 attendees)

Olsen, N. 2014. University of Idaho Kimberly Potato Research. Snake River Pest Management Tour, Kimberly, ID. June 25, 2014. (60 attendees)

Wenninger, E.J., N. Olsen, M. Thornton, P. Nolte, J. Miller, and A. Karasev. "Monitoring potato psyllids, *Candidatus* Liberibacter solanacearum, and zebra chip disease in Idaho." Pacific Branch Entomological Society of America meeting, Tucson, AZ, 2014. (30 attendees)

Wenninger, E.J., N. Olsen, M. Thornton, P. Nolte, J. Miller, and A. Karasev. "Potato psyllid and zebra chip update." Idaho Potato Conference, Pocatello, ID, January 2014. (60 attendees)

Olsen, N., E. Wenninger, and A. Rashed. 2014. Zebra chip. 46th Annual Idaho Potato Conference. Pocatello, ID, January 22, 2014. (60 attendees)

Olsen, N and E. Wenninger. 2014. Idaho Zebra Chip Saga. Far West Agribusiness Association Conference. Twin Falls, ID, January 7, 2014. (70 attendees)

Wenninger, E.J., N. Olsen, M. Thornton, P. Nolte, J. Miller, and A. Karasev. "Potato psyllid and zebra chip update." Far West Agribusiness Association conference, Twin Falls, ID, January 2014. (25 attendees)

Wenninger, E.J. N. Olsen, M. Thornton, P. Nolte. "Monitoring of potato psyllids, *Candidatus* Liberibacter solanacearum, and zebra chip in Idaho during the 2013 growing season." SCRI Zebra Chip Annual Reporting Session, San Antonio, TX, 2013. (80 attendees)

Miller, J. and E.J. Wenninger. "Potato psyllids and ZC insecticide trials." Idaho Association of Plant Protection meeting, Jerome, ID, 2013. (60 attendees)

Wenninger, E.J. "Potato psyllid and zebra chip update." Northwest Coalition for Alternatives to Pesticides field day, Aberdeen, ID, September 2013. (50 attendees)

Henne, D. and E.J. Wenninger. "Potato Psyllid Trapping and Management." www.plantmanagmentnetwork.org, August 2013. (40 attendees)

Olsen, N. 2013. Zebra Chip Update. IACI Raw Product Committee, Idaho Grower Shippers Convention, Sun Valley, Idaho, August 28, 2013. (50 attendees)

Wenninger, E.J. and N. Olsen. "Idaho research and extension efforts on zebra chip disease of potato." Idaho Legislative Tour, Parma, ID, August 2013. (60 attendees)

Wenninger, E.J. "Insect pest management studies in sugar beets and potatoes." UI Snake River Pest Management Tour, Kimberly, ID, June 2013. (25 attendees)

Olsen, N., T. Salaiz, J. Miller, and M. Thornton. 2013. Zebra Chip/Disease Control Roundtable. McCain Foods Grower Meeting, Burley, ID, March 13, 2013. (25 attendees)

Olsen, N., E. Wenninger, N. Gudmestad, and J. Miller. 2013. Zebra chip: Questions and Answers (workshop). 2013 University of Idaho Potato Conference, Pocatello, ID Jan. 23, 2013. (60 attendees)

Wenninger, E.J. and N. Olsen. “Zebra chip: a new insect-vectored disease in Idaho.” State Legislative Breakfast, Boise, ID, January 2013. (30 attendees)

Wenninger, E.J. “Insecticide Management for Potato Psyllids.” Idaho Potato Conference, Pocatello, ID, January 2013. (70 attendees)

Olsen, N. and E. Wenninger. 2013. Potato Psyllids and Zebra Chip 2012 Update. 2013 University of Idaho Potato Conference, Pocatello, ID Jan. 23, 2013. (70 attendees)

Wenninger, E.J. “Potato Psyllids & Zebra Chip: 2012 Update.” Idaho Potato Conference, Pocatello, ID, January 2013. (70 attendees)

Wenninger, E.J. “Potato Psyllids & Zebra Chip: 2012 Update.” Dow Agrosciences meeting, Pocatello, ID, January 2013. (40 attendees)

Olsen, N. 2013. Zebra Chip: Quality and Storage Considerations. 2013 Far West Idaho Winter Conference, Twin Falls, ID, January 8, 2013. (60 attendees)

Wenninger, E.J. “Potato psyllids and zebra chip in potato: identification, biology, and management.” Far West Agribusiness Association conference, Twin Falls, ID, January 2013. (60 attendees)

Publications

Swisher, K.D., V.G. Sengoda, J. Dixon, J.E. Munyaneza, A.F. Murphy, S.I. Rondon, B. Thompson, E.J. Wenninger, N. Olsen, A.V. Karasev, and J.M. Crosslin. 2014. Assessing potato psyllid haplotypes in potato crops in the Pacific Northwestern United States. American Journal of Potato Research; available online: http://link.springer.com/article/10.1007/s12230-014-9378-8

Development of Educational Material for the Food Service Industry to Enhance the Use of Dry Peas, Lentils, and Chickpeas (Dry, Edible Beans/Pulses) in Value-Added Products

Subrecipient
USA Dry Pea and Lentil Council

Project Summary
The USA Dry Pea & Lentil Council (USADPLC) was established in 1965 as a non-profit organization to promote and protect the interests of U.S. growers, processors, warehousemen, and sellers of dry peas, lentils and chickpeas (dry edible beans/pulses).

Educating the food industry on how to incorporate pulses into product lines can prove challenging. However, the use of more natural and healthful ingredients in value-added foods has become a priority in recent years, allowing pulses to gain recognition for their wholesome and nutritious profile. Pulses are one of the most cost efficient sources of protein and fiber. Additionally, pulses are gluten-free, cholesterol-free, have a low glycemic index score, and are high in potassium and other minerals. Research has found that pulses as ingredients can improve the nutritional and functional qualities of food products.

This project sought to utilize research on incorporating pulses into value-added food sector to further improve market access and development programs for pulses as mainstream ingredients through the training, education and dissemination of technical processing information to the food industry. The Council wanted to develop educational and informative videos and printed material targeting key decision makers in the food manufacturing and food service industry.

The USADPLC believes that domestic trade will be enhanced with continued promotion of pulses as ingredients in value-added foods. Over the last few years, the Council has partnered with various universities and technical food research firms to explore the functionality of pulses from whole, dry form to processed flours. The Council is seeing an increased awareness and demand for pulse flours and fractionations in value-added food items.

With increased cost associated with travel and time lost in the office, companies are looking for alternative ways to educate their employees on new technologies and ingredients. Having supported the technical research and product development efforts listed above and established the technical pulse processing methods ideal for commercial food use, the Council now aims to make this information readily available for professionals in the food/foodservice industry by creating online resources.

The use of pulses as value-added ingredients is still a relatively new concept, so there is a need to educate the industry on the technical properties of pulses as ingredients. In order to encourage the food industry in adopting pulse ingredients in their formulations, the Council requested funds to develop

these online resources. Activities conducted as part of this project aimed to promote the development of pulse-based foods in foodservice and retail food products.

Project Approach

Program

Webinars

The focus of the educational webinars was to provide targeted members of the food industry education on how to use pulses as ingredients and enhance nutritional value of foods.

- Best Vantage Inc. was selected to host and develop the four one-hour webinar series. Best Vantage Inc. is a market development and consulting company that specializes in food business and technology. This group was selected on the basis of their prior work with pulse related businesses, which gives them an added familiarity with pulse ingredients. In addition to their expertise, Best Vantage Inc. also has access to several contact databases that will be utilized in addition to the USADPLC contact database to promote the webinars. See Appendix 1 for Best Vantage biography.
- The confirmed speaker for the webinars includes Dan Best with Best Vantage Inc. Naggie Jeradechachai was on standby for the question and answer periods. If Naggie's schedule would not allow her to attend, she answered questions through email.
- The confirmed dates for the webinars were as follows:
    - June 20, 2013 *How to Use Pulses in Gluten-Free, Allergen-Averse Product Development*
    - August 22, 2013 *Pulse Ingredients as Egg and Diary Alternatives in Food Product Development*
    - September 24, 2013 *How to Use Pulse Protein in Value-Added Food Product Development*
    - November 7, 2013 *How to Use Pulse Fractions in Extruded Snack*
- Each webinar provided key technical information such as product formulations, process flows, the latest published research findings, and marketing considerations for new and traditional high value foods that utilize pulses as raw materials. The four webinars have been archived and are currently available through the Council's website www.pea-lentil.com, including the audio and the slides from the presentations. The final presentations can be found in Appendices 2-5.
- Naggie Jeradechachai developed the following formulations to complement the topics being worked on for the webinar. After testing the suitability of pulse ingredients in these applications, Naggie and the USADPLC reviewed the outcomes and determined the following applications to be used in the webinar presentations.

    Pulse Protein/ Flours in beverages

    1. Cinnamon-Vanilla Protein Beverage
    2. Chocolate-Flavored Protein Beverage

    Pulse Starch/ Flours

    1. Gluten-Free Chocolate-Chip Cookies
    2. Gluten-Free Pizza Crust
    3. Gluten-Free Pasta
    4. 100% legume Pasta

5. Battered, Breaded and Fried Chicken Strip
6. Pulse-Based 'Egg' Wash and Binder

Videos

The focus was to develop educational and informative videos targeting key decision makers in the food manufacturing and foodservice industry. These videos can also be used in other types of outreach with politicians, consumers, and dieticians.

- The USADPLC staff (Ali McDaniel, Mackenzie Femreite, Drex Rhoades), Northwestern Exposure and Culinary Sales Support Inc. (CSSI) all came together at the Resolution Studios in Chicago for filming of five educational videos in September. Resolution Studios was determined due to its close proximity to CSSI and ease of travel accommodations. CSSI provided the creative direction, copywriting, and talent for the videos. Chef Matt Luaders with CSSI was the confirmed speaker as Chef Robert Ritchie was unavailable at that time. Northwestern Exposure executed the video production component.
- Naggie Jeradechachai developed the finalized formulations and scripts that were used in the videos. Please Appendices 6-10 for the video scripts.
    - Video 1 Pulses the Heart of Healthy Cuisine, Intro to Lentils
        - Key message: Health benefits
    - Video 2 Pulses the Heart of Healthy Cuisine, Intro to Pulse Flours
        - Recipe: Chicken Tenders
    - Video 3 Pulses the Heart of Healthy Cuisine, Intro to Pea Protein
        - Recipe: Strawberry Protein Shake
    - Video 4 Pulses the Heart of Healthy Cuisine, Intro to Pea Starch
        - Key message: Substitute for corn starch
    - Video 5 Pulses the Heart of Healthy Cuisine, Into to Pea Fiber
        - Recipe: Strawberry Basil Granola Bar
- The videos are now finalized and will be made available on the Council's website and YouTube channel for the industry to use across all channels for educating on functionality, nutrition attributes and health benefits for DPLC's domestically and internationally.

Promotion

The target audiences for the webinars and videos were key decision makers in the food manufacturing and foodservice industry such as: product development specialists, manufacturers, dietitians, and food marketing professionals.

- The USADPLC promoted the webinars through targeted promotional outreach to companies and contacts made at trade shows and events (see Table 1) driven by food research, food marketing, and nutrition.

Table 1

CIA Healthy Menus Initiative	June 18, Napa Valley CA
Institute of Food Technologist	July 12-16 Chicago IL
CIA Culinary Course	September 17-19 Napa Valley CA
Food & Nutrition Expo Conference	October 19-23 Houston TX
International Foodservice Editorial Council	October 28-30 Portland OR

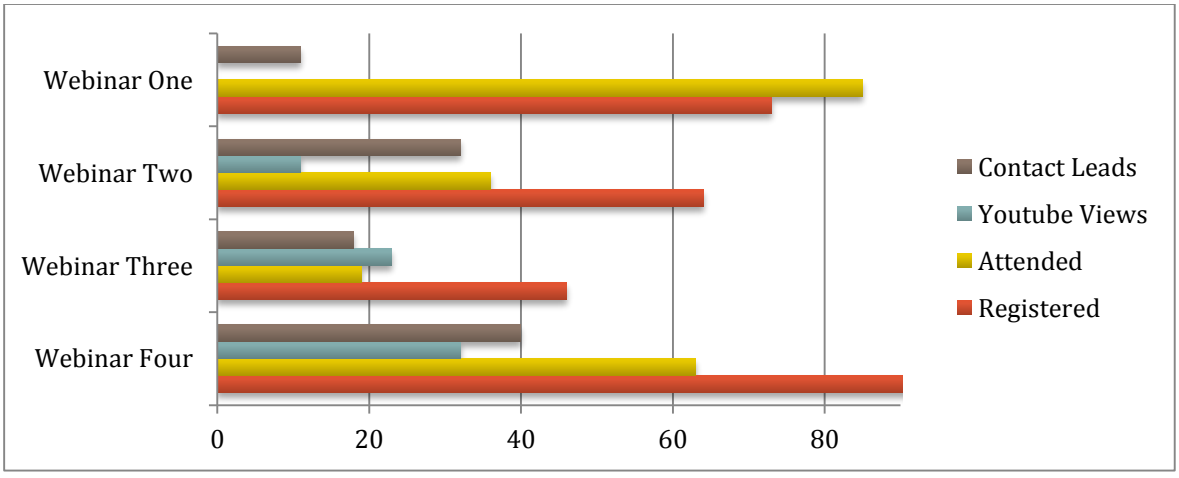
- Registration information was sent out to the Council's food industry database of over 900 contacts. Potential attendees could also sign-up for the webinars on the USADPLC's website.
- Best Vantage Inc. promoted the webinars to: an 846 private food industry executive contact list, an E-blast that included 56 food trade media contacts, a LinkedIn blast to 123,768 food industry professionals on Best Advantage Inc. LinkedIn network (note, this was sent through Groups, so there is likely a fair amount of replication in the numbers indicated) and Best Vantage Inc. posted a promotional review of each webinar on their website blog. Please see Appendix 11 for press releases.

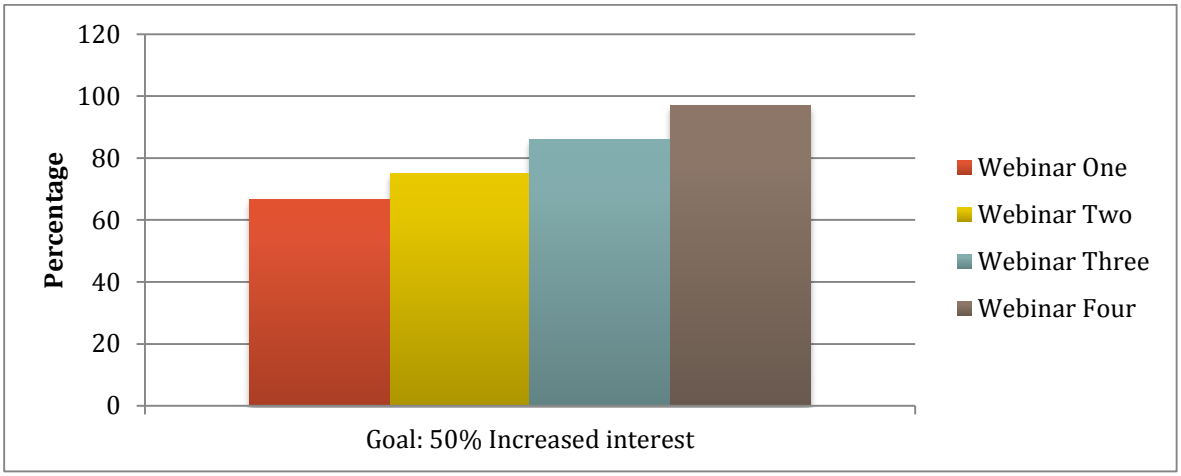
Significant Contributions

The USADPLC's mission is to promote dry peas, lentils and chickpeas through industry education, market development, research coordination and government affairs. The USADPLC is committed to the development of the pulse industry in the Pacific Northwest region and will show its commitment to this project by providing matching and in-kind contributions totaling $12,500 (Personnel $6,000 in-kind, Benefits $2,500 in-kind, Travel $4,000 cash match). This project creates economic opportunities for the pulse industry. The dedication and expertise of the Council, its industry members, expert speakers and venue partners who will be actively involved in the planning will create an opportunity for the project to meet all goals and expectations.

Goals and Outcomes Achieved

Results for the four webinars are as follows:





To make sure the Council achieved the performance goals and measurable outcomes for the project, participants received a survey after each webinar. The results are as follows:

- By September 2013, the Council was very pleased with how many contact leads and new partnerships had evolved due to the webinar series. At that time the increased awareness goals averaged 75.9% (goal was 50%) and contact leads at 61 (goal was 30) the Council set a new target goal of 80% increased awareness and a total of 70 contact leads.
- The Council is very happy to report the fourth webinar brought in 40 more contact leads, making a total of 101 contact leads out of 206 total actual attendees for the whole series. 49% of attendees reported formulating or testing with DPLC in the post webinar survey (the goal was 30%.) As for increased awareness goals, the original goal was 50% increased awareness; the Council set a new target goal of 80%. With the fourth webinar complete, the average ended up being 78.4%. Though the revised target was not met, it was an accomplishment in meeting the original goal of 50% and the Council came very close to reaching the revised goal of 80%.
- Due to pushing back filming for the videos as addressed under 'Lessons Learned' section, the Council was unable to show the videos at the scheduled trade shows mentioned in Table 1. However, with the videos being complete, the USADPLC is excited to have these resources available for upcoming shows in 2014. The international staff has also received the videos to use in their educational outreach, so these will be used around the world.

Beneficiaries

The primary beneficiaries of this project are the nearly 1,300 U.S. pulse farmers involved in growing dry pea, lentils and chickpea crops. These crops represent $382 million in direct and indirect farm income with the additional benefits of increased yield and the limited use of fertilizer in the rotations.

According to USDA/NASS 2011 production numbers, U.S. growers harvested 920,500 acres of dry peas, lentils and chickpeas accounting for ~550,000 metric tons of product. Idaho represented 98,400 of overall harvested acres of dry pea, lentil and chickpea and represented over 38% of all U.S. chickpea production. Production of dry peas, lentils and chickpeas has doubled in the past 5 years and there is

tremendous opportunity for additional growth. Moving more pulses into the domestic market for further processing would decrease grower and processor transportation costs significantly, thus increasing profitability to the growers and processors of Idaho.

Pulses also serve as excellent rotational crops that fix nitrogen in the soil and help break grain disease cycles which helps increase the yield of wheat and other major cereals.

To date, the pulse crops industry has been successful in marketing the annual production through international food aid and international commercial markets. There is now an added need to improve value-added food/foodservice markets. Expansion of these domestic markets would create new opportunities for the pulse crop industry and producers to diversify the marketing of pulse crops with a significantly higher value back to the producer.

Lessons Learned

Webinars

The Council's first webinar was hosted through Join.me. The first challenge was keeping active records through this service of who is on or who is off at one time during the webinar. Unfortunately, the Join.Me webinar service does not keep active records of that sort. The counter on the control console indicated that the first webinar had as many as 85 on at one time, which exceeds the number of people registered. Best Vantage Inc. speculated that some people at companies passed on the Join.me link to their colleagues.

The Council's second challenge was the post survey. Join.Me did not have an option to send out a post survey, so Survey Monkey was used. For subsequent webinars, the Council transitioned to Citrix Go-To-Webinar. With Citrix Go-To-Webinar there were more options all a crossed the board with development of surveys, reports, audio, and data collection.

The third challenge the Council faced is getting all the registrants to actually participate on the day of the webinar. Many registered to participate, but only got about 50 percent of those registered to join the webinar on its scheduled date. To take this on, the Council and Best Vantage Inc. sent out two more reminders, the day before and the morning of, in hopes participants would join in. With that said, the Council was contacted by 52 individuals after the webinar had been executed asking how soon the information will be archived on the Council's website due to missing the event. So the Council knows that this information is wanted and needed and possibly the scheduling was just poor timing for the participants' schedules.

Videos

The videos were to be filmed in March based on the work plan however, after consulting with the technical expert and video production team, September was discovered to be a better time. Moving the video filming date allowed technical expert Naggie Jeradechachai with Northern Crops Institute, and chef Matthew Luaders, with Culinary Sales Support Inc. more time to develop the concepts and prototypes for the videos.

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